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The Imperial Institute will be glad to receive regularly Indian, Colonial and Foreign publications, especially those relating to the commercial and industrial utilisation of mineral and vegetable products.

Communications, other than orders, concerning the "Bulletin" should be addressed to—

The Director,
Imperial Institute,
South Kensington,
London, S.W.

The principal reports and papers of the Scientific and Technical Department of the Imperial Institute for the last five years have been collected and issued in a volume entitled "Technical Reports and Scientific Papers." A limited number of these volumes has been placed on sale at the Imperial Institute at a price of fifteen shillings nett *plus* cost of postage.

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THE IMPERIAL INSTITUTE.

The Imperial Institute was founded as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May, 1893. The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of India and the Colonies, and providing for the collection and dissemination of scientific, technical and commercial information relating to them. Until the end of 1902, the Imperial Institute was managed by a Governing Body, of which the Prince of Wales was president, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900, the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the eastern and central portions being assigned to the use of the University of London. In July, 1902, an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of India and the Colonies, as well as of the India and Colonial Offices, the Board of Agriculture, and the Board of Trade. This Act took effect from 1st January, 1903.

In accordance with the above Act, the Imperial Institute is now managed by the Board of Trade in consultation with the Advisory Committee, through their Commercial, Labour, and Statistical Department, of which Sir Alfred Bateman, K.C.M.G., is Comptroller-General.

The Board of Trade have appointed Professor Wyndham Dunstan, F.R.S., hitherto Director of the Scientific and Technical Department, to be Director of the Imperial Institute at South Kensington, with charge of the various branches of work there carried on,

The work hitherto carried on by the Imperial Institute at South Kensington and in the City for the supply of general, commercial, statistical and tariff intelligence is now conducted by the Commercial Intelligence Branch of the Board of Trade, which, subject to the Comptroller-General, is under the direction of Mr. Thomas Worthington. (See statement as to the work of the Commercial Intelligence Branch published in the "Board of Trade Journal.")

The principal entrance of the Imperial Institute is at the west (Queen's Gate) end of the Imperial Institute Road. This gives

The Imperial Institute.

access to the principal floor, containing the general enquiry office, library, reading rooms, colonial conference rooms, and the library and reading room of the Northbrook Society.

The first floor contains the Director's office, the offices of the British Women's Emigration Association, the Colonial Nursing Association, and the general enquiry office in connection with the Indian and Colonial collections of commercial products.

The second floor is entirely devoted to the laboratories of the Scientific and Technical Department.

The public entrances to the Indian and Colonial collections are at the East (Prince's Gate) end and the West (Queen's Gate) end of the Imperial Institute Road.

The Imperial Institute works in co-operation with the Commercial Intelligence Branch of the Board of Trade at Whitehall, with an enquiry office in the City (49, Eastcheap, E.C.) under the management of this branch, and with the Emigrants Information Office in Westminster.

Indian and Colonial Economic Collections.—The collections of economic products illustrative of the commercial resources of India and the Colonies are arranged on a geographical system in the galleries of the Imperial Institute.

Special Curators are appointed by the Governments of India, Ceylon, Canada, and the Cape; whilst the operations of the Indian Section are supervised by a committee appointed by the India Office.

The collections are open free to the public daily, except on Sundays, from 11 a.m. till dusk.

It is intended, in consultation with the Governments concerned, to re-arrange and make extensive additions to many of these collections, and this work has been already commenced.

The following British Colonies and Dependencies are represented by collections of their products:—

BRITISH AFRICA.	BRITISH AUSTRALASIA.
Cape Colony.	New South Wales.
Natal.	Victoria.
Rhodesia.	South Australia.
British Central Africa.	Western Australia.
East and West African Settlements.	Queensland.
Mauritius.	Tasmania.
Seychelles.	New Zealand.
	Fiji.

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BRITISH AMERICA.

Dominion of Canada.
Newfoundland.
Bermuda.
Bahamas.
Jamaica.
Barbados.
The Leeward Islands.
The Windward Islands.
Trinidad and Tobago.
British Guiana.
British Honduras.

BRITISH INDIA AND THE EAST.

India.
Ceylon.
Straits Settlements and Federated Malay States.
Hong Kong.
British North Borneo.

OTHER BRITISH POSSESSIONS.

Malta.
Falkland Islands.

Information concerning India and the Colonies, their commercial products, industries, trade, prospects for emigration, &c., may be obtained on application to the Curators for India and Ceylon, Canada and Cape Colony, at their offices in the Sections, at the Central Stand in the Galleries, at the General Enquiry Office (No. 7, First Floor), or enquiries may be addressed in writing to the Director of the Imperial Institute, South Kensington, S.W.

The Scientific and Technical Department.—The laboratories of this Department, which occupy the second floor of the Imperial Institute, were established chiefly with the aid of grants from the Royal Commission of the 1851 Exhibition, in order to provide for the investigation of new or little-known products of India and the Colonies and of known products from new sources, with a view to their utilisation in British commerce, and also to provide trustworthy scientific and technical advice on matters connected with the trade and industries of India and the Colonies.

The work of the Department is chiefly initiated by Departments of the Governments of India and the Colonies. Arrangements have been also made by the Foreign Office, whereby British Consuls may transmit to the Department for investigation, such natural products of the countries in which they are appointed to reside as are likely to be of use to British manufacturers and merchants.

Materials are first chemically investigated in the laboratories of the department, which includes a staff of skilled assistants, and are afterwards submitted to technical trials by experts attached to the Department and finally are commercially valued.

Except under special circumstances the Department does not undertake investigations for private individuals.

A few illustrations of the work of the Department may be given here.

(*a*) The examination, in the Department, of Indian plants likely to be suitable as vegetable tanning agents now largely in demand, pointed to the conclusion that several would probably be useful to

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European tanners. One of these (*Cæsalpinia digyna*) was submitted to complete chemical investigation with very promising results. Tanning trials were next made on the large scale by one of the tanning experts attached to this Department, whose results confirmed the conclusion that a valuable tanning agent had been found. On the publication of the report on the subject, which was widely noticed in technical journals, a demand almost at once arose for the material in England, on the Continent, and in America, and the authorities in India are now arranging for the commercial supply.

(*b*) A plant abundant in India (*Podophyllum Emodi*) was found on chemical investigation in this Department to furnish the same constituents as the well-known drug of American origin, *Podophyllum peltatum.* The co-operation of physicians at St. Thomas's Hospital was secured, and preparations of the plant were extensively tried as a drug and found to be as valuable as those made from the American plant. A considerable demand now exists for the plant, which has been officially recognised by the Indian Medical Department, and arrangements are being made in India for a regular commercial supply.

(*c*) The same practical result has followed from the chemical investigation of a plant abundant in the Egyptian Desert (*Hyoscyamus muticus*) for which a commercial demand as a drug has also arisen.

(*d*) The quality of the entire series of Indian coals has been experimentally ascertained. These represented the principal coal-seams of India, and the report has been in large request both in this country and in India. It has now been issued as an official paper by the India Office.

(*e*) The cause of the poisonous effects produced, at certain stages of their growth, on horses and cattle by certain food grains and fodder plants of India and the Colonies has been investigated, and the nature of the poison and the conditions of its occurrence determined.

(*f*) The chemical composition of india-rubber of various kinds derived from the Colonies which do not at present share in this trade, has been determined experimentally, and on the basis of these results commercial valuations have been obtained, and in some instances sales of consignments of the material have been effected.

(*g*) Collections of minerals from British Central Africa, from Somaliland, and from Northern and Southern Nigeria have been chemically examined. In certain cases where it seemed desirable, minerals have been subjected to technical trial on the large scale by manufacturers, and commercial quotations for the products

The Imperial Institute.

obtained. Arrangements have also been made, through this department, for the working of mineral deposits in the Colonies by English firms.

(*h*) The quality of leather tanned in several of the Colonies has been experimentally investigated, and with the aid of experts its suitability for the English market has been ascertained and suggestions made for its improvement.

(*i*) The chemical composition of certain oil-yielding nuts sent by British Consuls in Brazil and Portuguese South Africa, and from British Honduras, has been investigated and their properties brought under the notice of British manufacturers and brokers. In several cases arrangements are being made for consignments of the products to be sent to this country.

(*j*) Scientific and technical information has been supplied as to the curing of tobacco (Bermuda), the working of mica deposits (Somaliland and Southern Nigeria), the suitability of iron ores for smelting (India), the production of wood-pulp (Natal), the cultivation of Indian hemp, and many similar subjects. It will be seen that the results of the work of the department are often of as much importance to British manufacturers as to the trade of the Colonies concerned.

The Technical Reports and Scientific Papers which have emanated from this Department since it was fully established in 1896 are about to be published.

Library and Reading Rooms.—The library and reading rooms of the Imperial Institute contain a large collection of Indian and Colonial works of reference, and are regularly supplied with a number of the principal official publications of India and the Colonies, and with many of the principal newspapers and periodicals of the United Kingdom, India, and the Colonies. The library also includes a number of Indian and Colonial maps and charts.

The library and reading rooms are on the principal floor of the main building, and are entered through the main entrance at the west (Queen's Gate) end of the building. These rooms can at present be used only by Life Fellows of the Imperial Institute, and by persons introduced by them.

Colonial Conference Rooms.—Three large rooms, specially decorated and furnished, are reserved on the principal floor for use by the representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The rooms in connection with this Hall are in the occupation of the Indian Committee of the Imperial Institute, whilst the Imperial Institute, the India Office

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and the London University have the right of using the Hall for lectures, meetings, &c.

Unofficial Societies occupying rooms in the Imperial Institute:—

(*a*) **The Northbrook Society.**—This Society (which was founded by the Earl of Northbrook) has a Library and Reading Room in the Imperial Institute which is available for the use of its members, who have also the privilege of using the adjoining Library and Reading Rooms of the Imperial Institute. The membership of this Society is open to natives of India and to persons officially connected with, or interested in, the Indian Empire. Communications should be addressed to the Secretary, Northbrook Society, Imperial Institute, S.W.

(*b*) **British Women's Emigration Association.**—The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and the prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants Information Office in Westminster.

(*c*) **Colonial Nursing Association.**—This Association has been assigned an office on the first floor of the Imperial Institute (Room 4). Its principal object is the selection of trained hospital and private nurses for the Crown Colonies and other British Dependencies.

INDIAN AND COLONIAL COLLECTIONS.

NOTES ON RECENT ADDITIONS.

Central Stand for Publications and Enquiries.—A stand has been opened in the centre of the main gallery to facilitate the answering of enquiries and the distribution of literature. Pamphlets, circulars, handbooks, &c., containing information relating to the commerce, agriculture, mining and other industries of the principal British Colonies, and also to emigration, may be obtained gratuitously. Certain publications are for sale. The publications of the Emigrants Information Office, established by the Colonial Office, may also be obtained. The principal Indian and Colonial newspapers may be seen on application.

An officer of the Institute is in attendance at this stand, which is being placed in telephonic communication with the offices of the Curators and with the General offices in the main building.

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Notes on Recent Additions.

India.—A large number of the exhibits in this section have been re-arranged. Preliminary lists of "edible substances," "oil-seeds and oils," "gums and resins," and "dyes and tans," have already been printed, and copies can be obtained gratis on application to the curator of the Indian section, or at the central stand.

An interesting collection of textile fabrics illustrating the use of wax, either for ornamental printing in relief on a coloured ground or as a resist for protecting certain portions of a design from the action of dyes, is being arranged in the Indian section, and will be completed very shortly. A fine collection of water-colour drawings of the orchids of Burma, by Mrs. Otway Cuffe, is temporarily on view in this section.

Canada.—A comprehensive collection illustrative of the economic minerals of British Columbia, and also an exhibit of furniture and carriages entirely manufactured in Canada of Canadian woods are being shown in the western end of the north gallery. A new collection of specimens illustrating the cereal resources of British Columbia has been added to the Canadian section.

Straits Settlements and Federated Malay States.—This section is about to be entirely re-arranged with many additions and improvements. Mr. H. N. Ridley, Director of the Government Botanic Gardens, Singapore, has now in course of preparation, new samples of economic products and other illustrations of the resources of these countries. Mr. Leonard Wray, Curator of the Museum at Perak, is also assisting in this work.

British Central Africa.—New samples of many of the important products of this Protectorate have been received and added to the collection. A description of these products will be found on p. ix.

Seychelles.—The Administrator of the Colony has recently forwarded for exhibition in this section samples of copra, cocoanut oil, cloves, pepper, cacao, coffee, vanilla, &c. These samples were placed on view for some months in the City Office of the Imperial Institute, where they came under the notice of brokers and merchants. Valuations of the products were forwarded to the Colony.

British North Borneo.—A collection of the commercial products of British North Borneo, including timbers, coal, rice, sago, sugar, coffee, cacao, pepper, tobacco and cigars, camphor, gutta-percha, dammars, cutch, gambier, is on view in the North Gallery.

Western Australia.—Furniture manufactured from the principal hardwoods of the State, chiefly Jarrah and Karri, showing the adaptability of these woods for moulding and turned work, as well as their susceptibility of a high polish and finish, is shown in the North Gallery.

Notes on Recent Additions.

Queensland.—A collection of the more important products of Queensland, especially minerals, and a large number of photographs illustrating the mining and agricultural resources of the country are being shown in the North Gallery.

Ireland.—The Department of Agriculture and Technical Instruction for Ireland has placed on view in the North Gallery (east entrance), for a period of three months, the collection of Irish minerals and building stones which formed one of their exhibits at the recent exhibition at Cork. The exhibit includes samples of the varied building materials and marbles in which Ireland is particularly rich. The beauty and excellence of the Irish granites, sandstones and limestones, as well as of the red, green and black marble and the other ornamental stones of the country are well known. The exhibit also includes specimens of clays, cement-making materials, and fine sands suitable for glass-making. In the mineral section of the exhibit are a series of prospector's samples of the metalliferous deposits of Ireland, and samples of Irish coal and other minerals now being worked.

The collection is in charge of Mr. St. John Lyburn, F.G.S., and full information is at the disposal of enquirers.

NOTES ON PRODUCTS RECENTLY RECEIVED FROM BRITISH CENTRAL AFRICA.

A number of new samples of products of British Central Africa have been recently forwarded to the Imperial Institute by H.M. Commissioner and Consul-General at Zomba, most of them having been collected by Mr. J. McClounie, head of the Scientific Department of the Protectorate. The samples have been sent for exhibition and for examination by the Scientific and Technical Department of the Imperial Institute. A descriptive report by Mr. McClounie contains the following particulars:—

Coffee.—It is gratifying to be able to state that owing to the inland position of British Central Africa and to precautionary measures enforced by the Government, coffee leaf disease is as yet unknown in the Shiré Highlands. Nearly all the coffee estates are situated at altitudes varying from 1,900 feet to 3,000 feet. The export of coffee from 1897 to 1900 was as follows:—

	Tons.		Tons.
1897	384	1899	959
1898	361	1900	557

The value of the coffee exported in 1901 was 14,751*l.*, as compared with 26,577*l.* in 1900. The decrease was due partly to the

Notes on Products Recently Received.

year having been unfavourable to the growth of the plant, and partly to the prevailing low prices.

Tea.—Tea was introduced into British Central Africa many years ago, but it is only within the last two or three years that efforts have been made to prepare the product for sale. It is not expected that there will be any extensive production for some years to come owing to the difficulty of obtaining seed for new plantations. The samples sent were prepared by hand.

Tobacco.—The samples of unfermented leaf show the product as taken from the drying sheds. The manufactured tobacco, although it might not pay on the London market, meets with a ready sale, locally and in Rhodesia, at remunerative prices. When experience has taught the planters how to produce a quality of tobacco suited to the English market, the production is expected to become highly remunerative, as the cost of labour and land is comparatively small, and the climatic conditions are favourable to the growth of the plant.

Rubber.—The sample of rubber is one of good quality, obtained from the indigenous Landolphias. The latter can be profitably cultivated only on a large scale as it requires about ten years to bring the plant from seed to a condition suitable for tapping. According to the latest report of Mr. Commissioner Sharpe to the Foreign Office (*Diplomatic and Consular Report, No.* 2,872, *Annual Series*), the amount of rubber exported from the Protectorate has considerably decreased. The rubber producing area was small and has soon been exhausted. The bulk of rubber now exported comes through the Protectorate from territories to the north and west.

Fibres.—The fibres sent are those of Sansevieria and Furcraea (Mauritius hemp). Sansevieria grows wild all over British Central Africa, and Furcraea is easily propagated and grows rapidly. Success in fibre cultivation, however, depends upon freights and markets, and as the freight to London is 10*l.* to 12*l.* per ton, and good fibre may fetch 20*l.* or a little over, the margin of profit to the grower is so small, after the cost of production has been paid, that he is induced to turn his attention to more remunerative products. The sample of Furcraea was valued by brokers in London at 26*l.* per ton, and was described as "clean, rather short, colour yellow"; the Sansevieria was described as "poor cleaning, length fair, colour yellow sandy, value 21*l.* per ton." The average value would be rather lower, as at the time of the above quotation prices were high.

Beeswax.—The samples received were prepared from material brought in by the natives. It is stated that beeswax might be easily produced in large quantities, and with considerable profit at present prices.

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Notes on Products Recently Received.

Ginger and Turmeric.—Small quantities of ginger are produced on several estates. From specimens grown in the Zomba Botanic Gardens, it appears that, if cultivated on the rich black soil so frequently met with in marshy places, ginger might become a fairly remunerative product. Its preparation for the market does not require expensive machinery, and its cultivation gives little trouble.

The samples of turmeric were obtained from indigenous plants. Low market prices, however, offer little inducement to cultivation.

Chillies.—These grow freely, even on poor land, and require little attention. Where the soil has been manured the bushes are extremely vigorous and crop heavily. In recent years chillie cultivation has been taken up by almost every planter in Nyasaland.

Gum.—The sample of gum, collected by natives, was obtained from trees at present unidentified.

Cotton.—The samples are from plants grown experimentally in the vicinity of Zomba. The results of the trial seem to show that there is little difficulty in growing cotton in the Protectorate. The climatic conditions are all that could be desired. Experiments have been made of late by many growers. When the necessary machinery has been obtained and the local transport companies have granted the reduction of freights promised for this special export, it is expected that cotton cultivation in British Central Africa will become general and extensive.

Timbers.—The samples of woods are from the Blantyre Mission. The tree known as "Mkungusa" or "Mlanje Cedar" (*Widdringtonia Whytei*) is the principal indigenous timber tree of British Central Africa.

"Mbawa" (*Kaya senegalensis*) is an indigenous mahogany, often attaining a great height and girth. The finest known example of this tree is at Mlanje; the bole rises 40 feet from the ground without a branch, and at the base has a diameter of 8 to 10 feet.

Ebony (*Dyospyros sp.*) is met with frequently on the plains at an elevation of about 2,000 feet. "Mwenya," "Msopa," and "Chiwimbi" are woods largely used in furniture making. Their botanical identity is unknown. "Mlombwa" and "Ngosa" are from North-east Rhodesia.

Ironstone.—The samples sent are from a deposit on the Songani Estate, which appears to have been worked by the natives for ages. The best specimens of the mineral are found surrounded by a thick bed of mica and clay.

Limestone.—The sample is from the Lake Shirwa Island, where the mineral is fairly plentiful at a height of 500 feet above the lake level.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

I.—REPORTS OF RECENT INVESTIGATIONS.

The following notices have been selected from reports recently made by the Scientific and Technical Department:—

THE INVESTIGATION OF POISONOUS FODDER PLANTS AND FOOD GRAINS.

The mortality among the transport animals during the recent Soudanese and Boer wars lends general interest at the present time to a subject which has always attracted attention among agricultural experts, especially in tropical and subtropical countries, viz., the occurrence in pasturage used by cattle of poisonous weeds. In England occasional losses of stock from this cause are recorded, but they are rare in comparison with the annual losses sustained by breeders in such countries as Australia, where, according to Maiden ("Plants reputed to be poisonous to stock in Australia, Sydney, 1901"), over 100 common meadow plants are reputed to produce toxic effects. Many of these are probably suspected without good reason, since, as the author points out in the pamphlet referred to, death frequently occurs among cattle as the result of indigestion ("hoven" or tympanitis) produced by immoderate consumption of a harmless plant, and the symptoms of such indigestion are not infrequently mistaken for toxic effects produced by poisonous fodder. To this cause must be attributed the different views held by many Australian stock-keepers as to the toxicity, or otherwise, of a particular plant, and a further difficulty is introduced by the fact recently established as the result of the investigation of a number of poisonous fodder plants in the Scientific and Technical Department of the Imperial Institute, that plants may be poisonous up to a certain period in their life history, and after that may become harmless and very valuable fodders. This has long been known to the Arabs to be the case with the great millet *Sorghum vulgare*, which they cultivate in enclosed fields until it is ripe, and only then allow their cattle to browse upon it.

During the last few years an inquiry into the nature of the poisonous constituents of a number of fodder plants has been carried on in this department of the Imperial Institute, and some of the results, which are interesting both from a practical as well as from a scientific point of view, have already been communicated to the Royal Society by Professor Dunstan and Dr. Henry, and have appeared in the *Philosophical Transactions* (1901, B. 205; 1902, A. 318). The publication of these results led to requests from many of the colonies for the investigation of plants reputed to be

The Investigation of Poisonous Fodder Plants.

poisonous, and at the present time a considerable number of these are under examination.

Lotus arabicus.—This plant is a kind of vetch indigenous to Egypt, where it grows along the bed of the Nile especially above Luxor. During the first Soudanese war this species of Lotus was a continual source of trouble to the military authorities, since it was frequently cropped by the transport animals at the various encampments and led to a high mortality among them. Specimens of the plant were sent in the first instance to the Director of Kew Gardens with a request for its identification and some information as to the nature of the poisonous constituent. As nothing was known on the second point the matter was referred to the Scientific and Technical Department of the Imperial Institute for chemical investigation. It was ascertained that the toxicity was due to the production of prussic acid, when the plant was moistened with water, as the result of the interaction of a glucoside and an enzyme occurring together in its cells. The glucoside (*lotusin*) was obtained in a pure state, and shown to be a derivative of a yellow colouring matter (*lotoflavin*), the latter, in addition to dextrose and prussic acid, being produced when lotusin is hydrolysed, either by the action of the enzyme (*lotase*) present in the plant, or by boiling it with dilute mineral acids.

The Arabs are aware that *Lotus arabicus*, which is called "Khuther" in the vernacular, is only poisonous in the immature condition, and that when allowed to ripen until seeds have formed it becomes innocuous and is then available as an excellent fodder. A chemical investigation of the fully ripe plants showed that they contained none of the poisonous cyanogenetic glucoside and were consequently harmless. The amount of prussic acid obtainable from *Lotus arabicus* is considerable and varies from ·26 per cent. in the case of young plants to ·32 per cent. in the case of those almost mature, when the yield of acid reaches the maximum.

Lotus australis.—This second species of Lotus is indigenous to Australia, where it occurs widely distributed on grass land throughout all the States. Opinion is divided there with regard to its toxicity; thus, von Mueller (Trans. Royal Society, Victoria, 1861—64, vi., 148) states that it is a "deadly poison," and that "sheep are frequently killed in half-an-hour by it." Maiden, on the contrary, is of opinion that the plant is a useful fodder, and that the deaths of cattle after its consumption are due to their feeding "too greedily upon it." Two small samples of *Lotus australis* were forwarded to the Imperial Institute by Mr. Maiden in 1900, the first, which consisted of fully developed plants, contained nothing of a toxic character, but the second sample, which had been specially collected and consisted entirely of immature plants, contained a glucoside which on hydrolysis furnished prussic acid,

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a yellow colouring matter, and a sugar. Further investigation, for which more material is required, may establish the identity of this glucoside with the lotusin of the Egyptian plant. The disappearance of the glucoside as the plant becomes mature explains the conflicting statements of von Mueller and Maiden, the former referring probably to the young plant and the latter to *Lotus australis* in the mature state.

Sorghum vulgare (the Great Millet).—A second Egyptian plant which has been investigated is *Sorghum vulgare*, which is known in Egypt as *Dhurra shirshabi*, in India as *juâr*, in South Africa as *Guinea corn*, and in America as *common sorghum*. This plant is grown throughout the tropics for the sake of the edible grain, which forms the staple food of the natives of India and other tropical countries, where the stem and leaves are used as cattle food. In Egypt, dhurra is cultivated solely as fodder, the grain not being in use as a food-stuff among the fellaheen, and perhaps for this reason a knowledge of the highly toxic character of the young plants appears to be more common there than elsewhere. In Java, the West Indies, and the United States of America occasional cases of poisoning by this plant have been recorded, although it is not generally regarded as poisonous; whilst in India toxicity is attributed to it only when grown in dry seasons or under other abnormal conditions.

Large samples of the Egyptian "dhurra" were sent to the Department at the instance of Mr. E. A. Floyer, of Cairo. These were examined and found to yield prussic acid when moistened with water, and ultimately a new glucoside (dhurrin) was isolated, which, when boiled with dilute mineral acids, underwent hydrolysis with the formation of dextrose, parahydroxybenzaldehyde and prussic acid. The agent producing this change of the glucoside in the plant is an enzyme apparently identical with that which occurs associated with the cyanogenetic glucoside amygdalin in bitter almonds, viz., *emulsin*. The amount of prussic acid obtainable from "dhurra" is in the case of plants from 18 ins. to 24 ins. high ·25 per cent., beyond this stage the amount rapidly diminishes, and in the mature plant the cyanogenetic glucoside has entirely disappeared.

Chailletia cymosa.—During the recent Boer war a number of poisonous plants from the Transvaal and Orange River Colony were sent to the Imperial Institute for investigation. One of these, a liliaceous plant, known locally as "tulp" (tulip ?), has only been obtained up to the present in quantities quite insufficient for a chemical investigation, but considerable supplies of the leaves of the shrub *Chailletia cymosa* have been received and are now being examined. Preliminary experiments have shown that the leaves furnish prussic acid when powdered and moistened

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with water, and from them a cyanogenetic glucoside has been isolated, and is being further examined.

Cassava (Manihot utillissima).—The tubers of the cassava plant (*Manihot utillissima*) cultivated in the tropics, and especially in the West Indies, have been asserted for a long time to *contain* prussic acid, and in the preparation of tapioca from the tubers special precautions are taken to wash the crude starch in order to remove this poisonous constituent. It is somewhat difficult to import cassava tubers into this country owing to the fact that fermentation occurs during the long sea voyage, with the result that the material generally arrives in a decomposed state. After several unsuccessful attempts to import whole tubers, arrangements were made with the Imperial Department of Agriculture of the West Indies to cut the tubers into slices and sun-dry these before export; in this way, through the kind offices of Dr. Morris and Mr. Bovill, sufficient cassava has been obtained for chemical investigation. The results, which are not yet complete, show that this plant also contains a cyanogenetic glucoside, which, in its decomposition, furnishes the prussic acid hitherto generally believed to exist *free* in the tuber.

Phaseolus lunatus.—Shortly after this enquiry into the nature of the poisonous constituents of fodder plants had been started, a paper was published by M. Boname, Director of the Mauritius Agricultural Station, ascribing to prussic acid the toxicity of the beans of *Phaseolus lunatus*. This plant is a near relative of the French bean, *Phaseolus vulgaris*, which it resembles in appearance and growth. In the wild state it produces beans of a deep purple or dark brown colour (Pois d'Achery), and in this condition the plant is grown for use as a green manure, though occasionally it has been eaten by cattle with disastrous results (Ann. Stat. Agron., Mauritius, 1900). When semi-cultivated the beans are white with patches of brown or purple (Pois Amer), whilst more careful cultivation results in the production of large perfectly white beans, which are used as a vegetable in tropical countries under the name Lima or duffin beans. Large samples of the beans produced under semi-cultivation in Mauritius have been received from M. Boname and examined in the Scientific Department of the Imperial Institute. They were found to contain a cyanogenetic glucoside and an enzyme which hydrolyses it in presence of water with the production, among other substances, of prussic acid. The glucoside has been obtained in a crystalline condition and its constitution determined, and a paper on the subject will shortly be communicated to the Royal Society. The Mauritius beans sent include about 20 per cent. of deep purple beans, about 30 per cent. of brown beans, and 50 per cent. of the light coloured variety. As it has been suggested that the dark coloured beans are more poisonous than the light coloured kind, specimens of each of these

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were selected from the mixture, and estimations of the amount of hydrocyanic acid producible from them made, when it was found that for this particular sample of Mauritius beans the brown variety produced ·109 per cent., the purple variety ·088 per cent., and the light brown kind ·081 per cent. of the poison.

Rangoon Beans.—Whilst the investigation of the beans of *Phaseolus lunatus*, from Mauritius, was in progress, there were received in the Department from seed importers in London a number of samples of a new seed, which was described as the Rangoon or Paigya Bean, and stated to have been recently largely imported into this country for use as a feeding stuff. These beans are slightly pink or light brown in colour with purple patches, are kidney shaped, and possess a well-marked white hilum. In general appearance they closely resemble the light coloured beans of the Mauritius samples of *Phaseolus lunatus.* At the request of the importers they were chemically examined at the Imperial Institute, and found to furnish a small quantity of prussic acid. It is a matter of some difficulty to estimate accurately small quantities of this acid, but by working with sufficiently large quantities of the beans, and using a specially devised process for the estimation of prussic acid, it was found that the average yield of prussic acid from the Rangoon beans was about ·004 per cent. It is impossible to say, without an extensive series of feeding trials, whether such a small amount of a cyanogenetic glucoside as would produce this quantity of hydrocyanic acid would exert any toxic action on animals fed for long periods with meal prepared from these beans; but having regard to the fact that the Rangoon or Paigya beans are probably the product of *Phaseolus lunatus*, or some closely related plant, and that the beans of the former may contain a sufficient quantity of cyanogenetic glucoside to produce ·11 per cent. of hydrocyanic acid, it seems inadvisable to encourage the importation of this material for cattle food, even although it should be shown by feeding trials that some of the present importations are harmless, and advice to this effect has been given to the firms concerned. It is, of course, possible that a method of manufacturing the beans into a harmless feeding stuff may be devised. The foregoing examples of the progress made in the investigation of poisonous fodders, plants and food grains will show that it has brought to light the remarkable fact that many of these at certain stages of growth contain a constituent furnishing prussic acid, and that where this occurs in the young plant it disappears as maturity is reached. In the course of this enquiry a number of plants reported to be poisonous have been examined and proved not to owe their poisonous effect to this cause. These include the poisonous *Gastrolobiums* and *Oxylobiums* of West Australia, which have already been investigated

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by Stockman, but without any very conclusive results as to the nature of the poison. These West Australian "poison bushes" are extremely destructive to cattle, and large numbers are lost in the colony every year by their agency. (Maiden., *loc. cit.*) The poison appears to rapidly enter the circulation, and to stop the action of the lungs and heart. The raw flesh of the poisoned animal is toxic to dogs, but after cooking is eaten with impunity by the natives. (Drummond, "Hooker's Journal of Botany.")

Among other poisonous seeds which have been submitted to a preliminary investigation and shown not to contain cyanogenetic glucosides are those of *Leucoena glauca* and *Pachyrizus tuberosus*. The former is commonly grown as an ornamental tree in tropical countries, and is occasionally planted in the countries bordering on the Mediterranean; the latter is a climbing leguminous tree with large tuberous roots, and is indigenous to the Straits Settlements.

Lathyrus sativus.—Attempts have also been made, but so far without success, to isolate the poisonous constituent of the seeds of *Lathyrus sativus*. This plant, which belongs to the order Leguminosæ, grows wild, and is partially cultivated throughout India, where its seeds are eaten by the natives in times of scarcity. It is stated by medical men in that country that continuous consumption of this pulse as a food over long periods produces in those who eat it a cerebro-spinal disease, resulting in paralysis of the lower limbs. This disease is of frequent occurrence in India, and is known as "lathyrism." The peas of the plant are also occasionally imported, mixed with other seeds, into this country from India, and in 1891 a large number of horses were poisoned in Liverpool as the result of being fed with such fodder. In the same year "lathyrism" appeared among the Russian peasants of Saratov as the result of the importation of large quantities of this pulse, which was used for the preparation of bread owing to the scarcity of wheat in that year. On the other hand, the same plant is cultivated in Canada, where the seeds, owing to their freedom from attack by pea-weevils, are extensively employed as a food and have never been known to produce toxic symptoms. The problem of isolating and identifying the toxic constituent of these Indian peas is an extremely difficult one, since to judge from the slowness with which the symptoms of "lathyrism" appear the amount must be small, and consequently it is difficult to obtain marked reactions either in chemical or physiological experiments. Maiden has already (*loc. cit.*) drawn attention to the similarity in the symptoms of "lathyrism" with those of the "loco" disease of cattle in Colorado, reputed to be produced by the consumption of various leguminous plants, such as *Astragalus mollissimus*. A number of these plants have been chemically

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examined, and from them no toxic substance could be isolated, so that the authorities of the Colorado Experimental Station concluded that the disease did not originate from the use of such fodders. The same is true of the "Nenta" disease of South Africa, popularly attributed to *Lessertia annularis* and other leguminous plants, and of the strange nervous disease which the "Darling Pea" (*Swainsonia galegifolia*) induces in sheep fed upon it in Australia.

These problems present features of great interest both to the physiologist and to the chemist, and some idea of their importance to an agricultural community may be gathered from the fact that during the years 1881–1885 the Colorado Legislature spent 10,000*l.* in awarding bounties to farmers and others who destroyed the roots of the plants supposed to produce "loco" disease.

It is intended to pursue the investigation of this subject in the Scientific and Technical Department of the Imperial Institute so soon as larger consignments of material are available.

COAL FROM TRINIDAD.

This coal is stated to have been taken from a deposit found on the south coast of Trinidad between the wards of Oropouche and Moruga.

The sample weighed about half a hundredweight and consisted of large and small lumps, together with a certain amount of powder. Inspection of the consignment showed that two varieties of coal were present. One laminated and easily broken along the lines of cleavage, discoloured in some places with oxide of iron and containing, between the laminæ, deposits of a white material which proved to be calcium sulphate. The fracture across the plane of lamination revealed a shiny black surface resembling bituminous coal. The second variety of coal present was more compact, giving a conchoidal fracture and revealing a black surface of considerable lustre. This variety more closely resembles cannel-coal or pitch in appearance.

For the purposes of analysis and technical examination a representative sample of the whole consignment was taken.

The analysis furnished the following results:—

Water (at 100° C.)	13·7	per cent.
Fixed carbon	33·99	"
Volatile matter	32·9	"
Ash	19·4	"

A separate determination showed that 9 per cent. of sulphur

Coal from Trinidad.

was present. The calorific value determined by the Thompson calorimeter was 4,378 calories, and the evaporative power, calculated from this result and representing the number of pounds of water at 100° C. converted into steam at the same temperature by the combustion of one pound of coal, was 8·1 units. The specific gravity of the coal ranged between 1·41 and 1·45. The coal burnt readily, giving off much gas which produced a highly luminous flame. The coal did not form coke but left a friable mass which almost at once fell to powder.

These results show that the coal is of inferior quality, the percentage of fixed carbon being only about one-half of that of a first-rate steam coal, and the calorific and evaporative values being also inferior. The coal, moreover, leaves a large percentage of ash, at least two or three times as great as is desirable. The percentage of sulphur is also very high, and this, together with the circumstance of the coal being non-coking, would render it unsuitable for most metallurgical operations. For general steam-raising purposes, too, the large amount of sulphur would be objectionable.

It is to be remarked that a considerable part of the sulphur revealed by this analysis is probably derived from the calcium sulphate present. It is possible that this substance might be removed, and the amount of sulphur correspondingly diminished, by washing the coal with water.

It is stated that the coal-seams crop up on the cliffs at the sea beach and are from 4 to 6 ft. in thickness, the edge of the seams being exposed on the face of the cliffs from the level of the beach to a height of 6 or 8 ft. The beds dip from west to east and lie at an angle of about 30° with the horizon.

If the sample now submitted were taken from the surface of the seam its inferior quality may be partly due to weathering, consequent on exposure to air and water.

KAOLIN FROM ST. VINCENT.

This sample of clay, stated to be Kaolin, was forwarded from St. Vincent for examination with a view to its commercial utilisation. The material was first submitted to complete chemical analysis and preliminary technical trials, after which it was forwarded to a pottery for further practical tests.

Chemical Examination.—The specimen consisted of soft white lumps of clay which were not homogeneous in composition, small

Kaolin from St. Vincent.

white opaque granules being present together with dark specks which were probably ferric oxide. The clay made a satisfactory paste with water which was easily worked and this paste after drying was white, and when heated in the muffle remained uncoloured, forming a fairly hard brick which showed no signs of fusion at higher temperatures.

The analysis of the original material furnished the following results:—

Silica (SiO_2)	63·04	per cent.
Ferric oxide (Fe_2O_3) ...	0·5	„
Alumina (Al_2O_3) ...	21·68	„
Lime (CaO)	trace.	
Magnesia (MgO) ...	0·72	„
Potash (K_2O)	0·39	„
Soda (Na_2O)	1·02	„
Water (combined) ...	8·17	„
Moisture	4·67	„

These results show that the clay is one belonging to the Kaolin series. It differs, however, in certain respects from representative samples of the Kaolin or China clay used in the manufacture of porcelain, chiefly in containing an excess of about 20 per cent. of silica, which would render it infusible and in other ways seriously interfere with its technical employment. It is to be noted, however, that Kaolin as mined is usually submitted to levigation by washing with water before it is employed in the factory, a procedure which often leads to the removal of a certain proportion of the silica.

The amount of clay from St. Vincent was so small that it was not possible to submit it to levigation. It is probable, however, that this would effect a considerable improvement in its quality.

Technical Trials.—Although the sample of clay was extremely small it was thought desirable that some trials in a pottery should be made in order to confirm the inferences from the results of the chemical examination.

The report from the pottery is to the effect that the clay is not satisfactory when burned, being too porous and short and also too infusible. It therefore could not be employed except in admixture with a stronger clay. It is noted as a satisfactory property that, after burning, the material remains white and shows no discolouration from the presence of impurities.

A further supply of about one hundredweight of the clay, preferably levigated by washing, has been asked for, so that additional trials upon a commercial scale may be made and the value of the material definitely ascertained.

TIN ORE FROM THE BAUTSHI TIN FIELDS, NORTHERN NIGERIA.

This sample of tin ore is stated to have been taken from a depth of about 6 feet from the surface of a plain lying to the north of a range of hills about 70 miles south-west of Bautshi in Northern Nigeria.

The specimen weighed about one pound, and consisted of small fragments, most of them less than one-eighth of an inch in diameter. The material proved to be chiefly composed of cassiterite or oxide of tin. On microscopic examination a number of small garnets and red grains of rutile were seen to be present, and magnetite and topaz in very small quantities.

The mineral, as received, furnished on analysis the following results:—

Tin dioxide (SnO_2)	81·30	per cent.
(equal to metallic tin 64 per cent.		
Silica (from garnets) (SiO_2) ...	1·0	,,
Titanium dioxide (TiO_2) ...	5·16	,,
Ferrous oxide (FeO)	6·63	,,
Alumina (Al_2O_3)	4·60	,,
Magnesia (MgO)	0·35	,,
Lead oxide (PbO)	0·25	,,

Calcium, copper, gold, and arsenic were absent.

It is evident that this is an excellent sample of tin ore, rich in tin and free from arsenic, which probably could be smelted direct after washing. It has been recommended that steps should be taken to ascertain the extent of the deposit, and a representative sample of about one hundredweight has been asked for in order to determine how far the composition of the deposit is uniform and also for technical trials as to the best method of smelting the ore.

FIBRES FROM SIERRA LEONE.

A number of fibres prepared in Sierra Leone were forwarded by the Government of the colony for chemical examination and commercial valuation. The specimens included the fibres of *Sansevieria guineensis*, *Furcræa cubensis* and *Elæis guineensis*; also a fibre named "Hibiscus fibre" by the natives, but probably derived from *Abutilon periplocifolium*, and varieties of banana and plantain fibres.

From the appearance of the fibres it was evident that they had been only roughly prepared, so that a portion of each sample was

Fibres from Sierra Leone.

carefully combed out and the selected material was used for the chemical examination. The original samples, together with the selected combed specimens, and also special remarks on the characters of the fibres were then sent to two well-known firms of fibre-brokers, who have been good enough to report on their commercial value.

Chemical and Technical Examination.—On chemical examination the fibres have given the following results:—

Name.	Moisture.	Ash.	Loss on Hydrolysis (*a*).	Loss on Hydrolysis (*b*).	Loss on Acid Purification.	Loss on Mercerising.	Gain on Nitration.	Cellulose.	Length of ultimate fibre.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	mm.	in.
1. *Sansevieria guineensis* ..	10·6	0·4	8·9	13·9	1·8	8·6	29·6	78·0	1·5–5	$\frac{1}{16}$–$\frac{1}{5}$
2. *Furcræa cubensis* ...	9·8	0·8	13·5	19·1	4·1	12·0	29·1	75·3	1·5–4	$\frac{1}{16}$–$\frac{1}{6}$
3. *Hibiscus Fibre (Abutilon periploeifolium ?)* ...	12·3	0·5	8·5	10·9	0·4	6·7	28·1	75·2	1·8–3	$\frac{1}{14}$–$\frac{1}{8}$
4. *Plantain Fibre*... ...	9·1	1·12	13·9	22·9	2·2	16·8	23·9	68·9	1·2–3	$\frac{1}{20}$–$\frac{1}{5}$
5. *Long Banana*	10·3	1·7	17·6	32·2	1·1	8·7	34·9	65·6	1·3–3·6	$\frac{1}{20}$–$\frac{1}{7}$
6. *Silver Banana*	10·0	1·9	18·6	26·5	2·1	9·8	31·2	63·2	1–3	$\frac{1}{25}$–$\frac{1}{5}$
7. *Elæis guineensis* ...	10·9	2·2	9·4	13·8	1·7	7·2	32·1	81·5	1·5–4	$\frac{1}{16}$–$\frac{1}{6}$

The following remarks may be made on the characteristics of these fibres:—

1. The fibre of *Sansevieria guineensis* is white and of considerable strength. This material appears to be identical with that known commercially as "African Bowstring Hemp," which has been stated to be of special value for rope-making, having many of the qualities of Manilla hemp. Some years ago a sample from Trinidad was valued at from 20*l.* to 23*l.* per ton. The Sierra Leone sample is now valued by one firm of brokers at 16*l.* per ton, and by the second at about 25*l.* per ton, it being pointed out that a better sample would be worth as much as 35*l.* per ton. The present sample includes some fibres which are very weak and of little value owing to improper preparation.

2. *Furcræa cubensis.*—This is a long white fibre and not so strong as the preceding. It has been seen occasionally in commerce and has been mistaken for true Sisal hemp, which it closely resembles. On a previous occasion a sample from Jamaica was valued at 28*l.* per ton. The Sierra Leone sample is valued by one firm of brokers at 13*l.* per ton, and by the other at 15*l.* The sample has been badly prepared and the fibre is probably not seen at its best.

3. *Hibiscus Fibre*—This is a strong fibre of a pale yellow colour. The sample sent was in long bands or ribbons. The bark of

Fibres from Sierra Leone.

Abutilon periplocifolium is known to furnish a bast fibre of good quality which is comparatively easy to prepare. It has been considered by some that this fibre might compete with jute. A sample from Trinidad has been valued at from 17*l.* to 20*l.* per ton. The present sample is compared by one firm with medium jute, probably worth from 13*l.* to 14*l.* per ton. The other valuation is, however, much lower, only 4*l.* per ton. It is to be remembered that this sample is badly prepared, and therefore compares unfavourably even with jute of medium quality.

4, 5, and 6.—The fibres numbered 4, 5, and 6 are Plantain or Banana fibres derived from *Musa paradisiaca* or *Musa sapientum*. The samples are very poor, being brittle and unfit to work. Even when properly prepared, Plantain fibre is known to be of small value except for certain purposes, as the manufacture of cordage and canvas, or of special fabrics, but in general it is deficient in strength. Usually its value has been put at from 12*l.* to 15*l.* per ton. The brokers report that the present samples are of no value, being brittle and generally poor in quality, an opinion which is borne out by the results of their chemical examination. In particular, the percentage of cellulose is low and the loss on hydrolysis much greater than is shown by the best fibres. Even allowing for the deficiency arising from imperfect preparation, it is very unlikely that any but local uses could be found for fibres of this class.

7. *Elæis guineensis.*—This is the most interesting of the group of fibres sent from Sierra Leone. It is a very strong fibre of fine appearance, of great length, and remarkable also for its pale greenish-yellow colour. The results of its chemical examination are most satisfactory, and prove it to be a fibre of the first class. This fibre has from time to time appeared on the market, but it has been hitherto concluded that the cost of production is so great as to make it impossible to prepare it in quantity at any but a prohibitive price, even with the advantage of native labour. There can be no doubt that if a cheap method of separating the fibre from the leaves could be devised and worked in the Colony the fibre would be well worth exporting. So far as can be ascertained, the only use to which it has been put up to the present time is for the local manufacture of fishing lines and fine cordage. The present sample is valued by one firm of brokers at 25*l.* per ton; the other firm reports that "this fibre is frequently sampled, but never comes in sufficient quantity to bring reliable quotations. If sent in moderate quantities, say a ton or two at a time, and a certainty of getting a constant supply, probably a market could be found for it at 50*l.* per ton and upwards. Oddments would sell at much less, as no manufacturers would take up a new material at its full value before regular supplies can be assured."

ARAMINA FIBRE FROM THE "CARRAPICHO" PLANT OF BRAZIL.

This fibre was referred to by Consul-General Rhind in his report on the trade of Rio de Janeiro for the year 1899, under the name of "guaxima." *(Foreign Office Diplomatic and Consular Report, No. 2,475, Annual Series.)* He is of opinion that it may possibly compete with jute as a material for the manufacture of sack-cloth, the threads being very long and resisting the action of water, so that they can be employed by fishermen in making nets.

In the despatch Mr. Rhind quotes the opinion of Dr. Silva Tolles, of the Sao Paulo Polytechnic School, to the effect that the fibre, which is probably derived from *Urena lobata,* is likely to be of great value for cloth-weaving, spinning, and other purposes, it being more silky and stronger than jute and comparable with the best kinds of hemp. It is stated that information as to the cost of production and price cannot yet be given, as systematic cultivation is only in an experimental stage. It is, however, known that the plant is easy to grow, and the cost of production will probably therefore be very low.

The sample sent by Mr. Rhind was almost too small for systematic examination. On this account the remarks made in this report must be regarded as provisional, a decisive opinion as to the value of the material being reserved until a larger quantity has been examined.

The specimen consisted of fine silky fibre of great length in staple, having in general the characteristics of the best jute, but very much less lignified and of good colour. The results of its chemical examination are recorded in the following table:—

Moisture	13·38	per cent.
Loss on (*a*) Hydrolysis	17·69	,, ,,
Loss on (*b*) Hydrolysis	17·56	,, ,,
Loss on Acid Purification ...	2·5	,, ,,
Loss on Mercerising	19·37	,, ,,
Gain on Nitration...	35·65	,, ,,
Cellulose	75·73	,, ,,
Length of ultimate fibre	1·5-3·5	mm.
Length of staple	6	feet.

These results show that the fibre is of excellent quality, owing to the considerable length of staple, the high percentage of cellulose, and the small loss by acid purification. The numbers recorded show considerable resemblance to those obtained from jute of the best quality.

Aramina Fibre from the "Carrapicho" Plant of Brazil.

A portion of the sample was now submitted, with a statement of the results of its chemical examination, to a well-known firm of fibre-brokers, who report that it could be employed for the same purposes as fine jute. Its value is estimated approximately at from 17*l.* to 18*l.* per ton. The brokers state, however, that it is impossible to give the precise value of the fibre until a much larger quantity has been examined with special reference to its behaviour during spinning, weaving, and other processes to which it would be submitted. They suggest that a hundredweight or two should be sent in order that these further trials may be made.

In his report upon the trade of Rio de Janeiro for 1901 (*Foreign Office Diplomatic and Consular Report, No.* 2,928, *Annual Series*), the Consul describes the steps which have since been taken to utilise this fibre locally. Numerous experiments having demonstrated its excellent qualities, samples of rope and other woven materials were manufactured from it, and an exhibition of these products was held in the City of Sao Paulo. The plant is now being extensively cultivated, and a factory has been erected at Sao Paulo exclusively for the manufacture of goods from aramina fibre. The price paid at the factory for the clean fibre is about 1*d.* per lb.

COHUNE NUTS FROM BRITISH HONDURAS.

About a dozen nuts were received, and, with one exception, all were without shells. The nuts were about the size and shape of large nutmegs, and when cut with a knife presented the appearance of cocoanut, which they also resembled in smell.

These nuts are the product of the Cohune Palm, *Attalea Cohune*, which is very abundant in British Honduras. Each tree is said to be capable of furnishing over 1,000 nuts, which are known to be rich in oil, but hitherto have been little utilised, chiefly owing to the difficulty of shelling.

Chemical Examination.—The kernels when ground were found to furnish by extraction with ether, rather more than 40 per cent. of a fixed oil which gradually solidified to a yellowish fat, having the general appearance of cocoa and palm nut oils. The oil cake left after the extraction of the oil was found to contain 2·5 per cent. of nitrogen, and therefore might be useful as a feeding cake.

Cohune Nuts from British Honduras.

The physical and chemical constants of the oil have been determined with the following results :—

Melting point...	18-20° C.
Solidifying point	15-16° C.
Saponification equivalent	253·9-255·3.
Iodine absorption	12·9-13·6.
The fatty acids from the oil melted between..	27° and 30° C.

It thus appears that Cohune nut oil closely resembles cocoa and palm nut oils, and could, no doubt be utilised for the same purposes as these oils. The Cohune oil was found to saponify readily, forming a soap which was almost entirely free from smell. This material would therefore probably be of value for the manufacture of the finer soaps.

Commercial Valuation.—A few of the nuts were sent to a well-known firm of brokers who were informed of the chemical properties and probable uses of the oil. They were requested to furnish a commercial valuation, and to state their opinion on the question of removing the very hard and thick shells from the kernels.

The brokers report that the nuts are of fine quality and would probably fetch about 15*l.* per ton, if delivered shelled. They were unable to give a valuation for the unshelled nuts, and pointed out that it would probably be necessary to shell them by hand, which would be an expensive proceeding in England.

A further supply of the unshelled nuts has since been forwarded, and from the examination of these it is clear that the shells will have to be separated from the kernels before the oil is extracted, as otherwise the quality of the latter is considerably impaired. The shells are exceedingly hard so that their removal by hand is held to be impracticable, and at present there does not appear to be a machine in the market which would be suitable for the purpose. Further action has been, therefore, taken with a view to the construction of a special machine.

MAFOUREIRA NUTS FROM PORTUGUESE EAST AFRICA.

Attention has been drawn by Mr. Vice-Consul Parminter, in his report on the trade of Inhambane for the year 1900 (*Foreign Office Diplomatic and Consular Report, No.* 2,630, *Annual Series*), to the large trade which is being done with France in the Mafoureira nut. He remarks :—

"This year there has been a very large trade done in

Mafoureira Nuts from Portuguese East Africa.

'Mafoureira,' a nut containing a large percentage of thick, heavy oil. I am told here that this nut can only be profitably worked at Marseilles, but if lubricants, and, I believe, soap and candles, can be made in France from 'Mafoureira,' why can it not be done also in the United Kingdom? (Small bags of samples of the nut will be sent to manufacturers on application being made to this office.) The supply is practically unlimited, the tree bearing the nut grows wild all over the country, it can be bought here for little more than a ½*d.* per kilo. (about 42*s.* a ton), and it sells in Marseilles at 8*l.* per ton. Freight on this produce to Marseilles comes to 50*s.* per ton, a rate which, owing to want of competition, is excessive."

As very little is known of the properties of these nuts in this country they were first submitted to chemical examination.

The sample sent from Lourenço Marques consisted of small brown nuts covered with a thin shell which is easily detached by rubbing. The average size of the nut is half an inch in length and about a quarter of an inch in diameter; about 1,600 nuts weigh one pound. The kernel presents a very oily appearance and has an acrid taste. The amount of oil is so large that it is not possible to grind the nuts to a powder with a pestle and mortar. The oil can be readily removed from the nuts by pressure applied to the warm material, and it is very readily removed by the usual solvents, especially by ether, which was employed for the purpose of these experiments.

Separating the kernels from the easily detachable shells it was found that the kernels amounted to 88 per cent., and the shells to 12 per cent. of the total weight. The entire nuts furnished, by complete extraction with ether, 61 per cent. of a fatty oil, whilst the kernels alone furnished 68 per cent., and the shells alone 14 per cent.

The oily constituents of the nut are solid at the ordinary temperature, so that in this respect the material resembles fats of the same class as palm oil, cocoanut oil, &c.

When submitted to chemical examination Mafoureira fat furnished the following results:—

——	Melting point.	Solidifying point.	Acid value.	Saponification value.	Iodine value.
Fat from entire nuts ...	37° C.	20°–25° C.	32·5	2·40	55·8
Fat from kernels only ...	40° C.	25°–30° C.	42·4	2·41	47·8

Further examination of the fat showed that it is chiefly composed

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of palmitin and olein, together with some free fatty acid, chiefly oleic.

It is clear from these results that the fat from Mafoureira nuts is a valuable product, especially if it is obtained from the kernels without the shells. It melts at a higher temperature than any other vegetable fat of this class, and there is no doubt that it would be of considerable value for the manufacture of soap and candles. Owing to its acidity it is not adapted for lubricating purposes without special treatment, and the same remark applies to its employment for pharmaceutical and edible purposes. It is, however, a product which deserves far more attention than has been hitherto bestowed upon it.

In order to gain precise information as to its commercial utility and value, samples were submitted, together with the above-mentioned results of its chemical examination, to a well-known firm of brokers in this kind of produce, and also to a firm of soap and candle manufacturers.

The brokers report that they estimate the value of the Mafoureira nut at from 8*l.* to 9*l.* per ton delivered in Hull in consignments of not less than from 50 to 100 tons; and these brokers are ready to undertake the charge and sale of any consignments which may be forwarded.

In connection with this estimate, it should be remarked that there is always a difficulty in obtaining a price for a new product, even when its properties and uses can be exactly indicated. There can be little doubt that if a regular supply were sent, that prices would improve as the valuable properties of these nuts became more fully recognised.

The soap and candle manufacturers report that some years ago their attention was directed to this product, but apparently no business resulted. They are of opinion that if the full value of the fat from these nuts is to be realised, the fat should be expressed on the spot, and this sent to the London market instead of the raw material, following the practice which is carried out with such success in the case of the similar fat derived from Palm kernels. They further remark that "the great difficulty in obtaining a proper market for new commodities of this description lies not so much in the want of value in the articles themselves, as of the difficulty of assuring a constant supply. As a rule, no sooner is a new oil put on the market than the price asked makes it practically prohibitive for it to be properly exploited over here. If a small but continuous market could be created at the commencement there is not the slightest doubt that this, as well as other African or Colonial oils, &c., would speedily find an increasing sale, and their proper level in money value, and this

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is particularly the case in the present high state of the tallow and allied markets generally."

It may be added that it seems probable that the "cake" remaining after the expression of nearly all the oil from the nuts might be utilised as a feeding material for cattle. Chemical examination has shown that it contains nearly the same percentage of nitrogen compounds as linseed cake. This is a matter which requires further investigation.

In the light of these reports it seems desirable to ascertain whether it would be possible to arrange for the crushing and pressing of the oil from these nuts in South Africa. If not, it might be considered remunerative to export the raw material at the provisional rates stated above.

This Department will be glad to render any assistance in connection with putting this material on the market here, and if necessary in ascertaining whether any English firm in South Africa would be willing to undertake the expression of the oil. For this purpose it would be necessary to furnish full information as to the available supply of the material, and as to the agents with whom such firms might be put into communication.

Bulletin of the Imperial Institute.

II.—GENERAL NOTICES.

(*Prepared by the Scientific and Technical Department.*)

THE CHEMICAL ANALYSIS OF GUTTA PERCHA AS A GUIDE IN ITS CULTIVATION AND VALUATION.

The increasing demand for gutta percha and the possibility of an exhaustion of the supply, have directed attention to the necessity of establishing gutta percha plantations in suitable localities, a method already largely adopted in the case of rubber. In selecting gutta percha trees for cultivation, great care has to be exercised, since the botanical identification of the different species is extremely difficult, and many of them which exhibit scarcely any variation in botanical characters nevertheless yield gutta percha of very different quality. It has been recently suggested by MM. van Romburgh and Tromp de Haas (*Journal d'Agriculture Tropicale*, No. 19, p. 11), that the chemical analysis of the gutta percha obtained from the different trees should be used as a guide in selecting the best varieties for cultivation, and further that if manufacturers would insist upon buying gutta percha on the basis of the amount of true "gutta" contained in it, as ascertained by analysis, the extensive sophistication to which the commercial article is at present subjected would speedily be put an end to.

The collection of gutta percha is largely in the hands of the natives, and as the best qualities are only yielded by a few species, which are becoming less numerous owing to the destruction caused by careless treatment, there is almost invariably a considerable admixture of inferior gutta percha, of which there is a large supply; and in addition, quantities of bark or other impurities are frequently included. Similar adulteration of the product is practised by the Chinese merchants who act as middlemen, with the result that the gutta percha of commerce is rarely the product of a single species. It is usually a mixture of different guttas of unknown origin. Little is known of the composition of many of these inferior guttas, or of the influence they exert upon the properties of true gutta percha, and the valuation of these mixed products demands considerable knowledge and experience. In general, however, a gutta percha containing a high percentage of true "gutta" (the hydrocarbon to which the characteristic properties are due) has the greatest commercial value, and as the amount of this substance could be determined in all cases by analysis, the authors suggest that analysis would afford a logical basis for valuation. The price would depend upon the percentage of "gutta" present. Such an arrangement would remove to a very large extent the inducement which at present exists for the

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collectors and merchants to mix inferior qualities with the best, since by so doing they would correspondingly reduce the value.

This scheme of valuation will require a method of analysis at once rapid and exact, and the authors have devised a new process which they regard as superior in these respects to those at present in use. The results of a number of analyses are given, and may be quoted as showing the extreme variation in composition met with among the commercial varieties of gutta percha. The specimens represent the different kinds which were offered for sale in the market at Singapore, and for comparison the price is also given in dollars per picul (1 picul being equal to about 135 lbs.).

Commercial Name.	Impurities	Water.	Resin.	Gutta.	Value.
	per cent.	per cent.	per cent.	per cent.	Dollars. per picul.
Bila red Soondi	33·6	7·0	31·4	28·0	150
Sarawak Soondi, No. 2.	37·1	6·8	26·5	29·6	155
Pinang gutta Palelo, No. 1 ...	2·1	5·8	53·8	38·3	100
Sarawak red Soondi, No. 1 ...	19·0	3·9	35·5	41·6	360
Bagar white Soondi, No. 1 ...	0·7	8·6	36·5	54·2	350
Kœtei guta Merah. No. 2 ...	21·7	5·1	28·3	44·7	360
Indragiri white Soondi	2·0	4·1	46·2	47·7	370
Sambas white Soondi ...	1·0	4·4	53·6	41·0	380
Kœtei guta Merah, No. 1 ...	14·8	3·8	34·8	46·6	500
Pahang white Soondi, No. 1 ...	4·2	0·5	12·8	82·5	500

With reference to the selection of trees for cultivation, the authors suggest that in cases of doubt as to the identity of particular trees a comparative analysis of the gutta percha would prove a trustworthy guide, and they record some experiments which have been made to test this view in the Botanic Gardens at Buitenzorg. Here a number of gutta percha trees are under cultivation with a view to the production of seeds for the establishment of plantations. It was therefore important to make sure that only the best varieties were utilised. In view of the fact that the identity of some of these trees was regarded with suspicion, experiments were made to ascertain whether this uncertainty would be confirmed by the results of the analysis. Seven trees of *Palaquium borneense* were tapped and a little gutta percha withdrawn for analysis: the results in six cases showed the presence of from 81 to 86 per cent. of true "gutta," whereas the seventh specimen only yielded 50 per cent. The latter tree has therefore been rejected. In each of the species *Palaquium oblongifolium* and *Palaquium Treubii* a suspected tree was found, and similar analyses were made. The gutta percha obtained from the former consisted of 68·8 per cent. of resin and 35·2 per cent. of gutta, that from the latter gave 75·7 per cent. of resin and 24·3 per cent. of gutta. It was clear from these results that neither of these trees could be regarded as belonging to the species

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in which they were placed, as both of these yield gutta percha of much better quality. Similar observations confirming the above results have also been made in the plantations at Tjipetir.

The chemical analysis of the gutta percha would therefore appear to be of value in such cases of doubtful identity, and, provided that due consideration be given to the physical properties, it might also afford a suitable basis for commercial valuation.

It may be added that for some years past samples of india-rubber and gutta percha received from India and the Colonies have been examined in the laboratories of the Scientific and Technical Department of the Imperial Institute, and the results thus obtained have been taken into account in connection with the subsequent commercial valuation of these products.

RUBBER CULTIVATION IN THE CONGO FREE STATE.

During the last few years a number of rubber plantations have been established in the Congo Free State. An interesting description of one of the largest of these has recently been given by M. Bemelmans in the *Revue des Cultures Coloniales,* No. 116. All the principal rubber trees have been introduced upon an extensive scale in this plantation; and, as the experience gained may be of value in other cases, a short account of the experiments is here given.

Manihot Glaziovii (Ceara rubber tree).—The seeds of this plant possess a very hard coat, which protects them from damage during transit, but renders germination slow and uncertain. Several methods for obviating the latter difficulty have been suggested, and, after trials of these, the plan of cutting off the end of the seed was adopted as being the most suitable. This process is very expeditious, as four boys can prepare from six to eight thousand seeds per day, and from 30 to 60 per cent. of the seeds so treated germinate within ten days. The seeds are sown very superficially, at the rate of 500 to a bed 5 metres by 1·5 metres, and this should be screened from the sun for a fortnight or three weeks. At the end of two or three months the seedlings have attained a height of from three-quarters to one metre, and are then planted out at intervals of three metres in every direction; it is desirable to remove some of their leaves at the same time. The plant stands transplanting very well, and the losses, never greater than 10 per cent., are replaced during the first fortnight. One advantage of planting the trees widely apart is that they then offer less resistance to the wind, a point of some importance, as the roots are very superficial and the young trees are easily blown down. At

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first the ground requires attention once a month, and in these operations great care must be taken to avoid injuring the surface roots. The tree attains a height of about three metres in the first year, and at the end of the second it is five metres high and half a metre in circumference. Longitudinal incisions made in two-year old trees gave 20 to 30 grams of a thick latex, and the rubber from this was valued at 6 fr. to 7·50 fr. per kilog. according to the method of coagulation employed. At the end of the first year *Manihot Glaziovii* produces seeds, three of which occur in each fruit, and the easiest method of collection is to pick the capsules before they dehisce. In view of the abundant supply of seeds and the facility with which plants can be raised from them, propagation by slips is almost superfluous, but can readily be accomplished by selecting a sufficiently large piece from the well-seasoned wood

Hevea brasiliensis (Pará rubber tree).—The seeds of this species are much more difficult to transport without damage, and experiments with them have not given very good results; but 5,000 seedlings have been successfully imported in Wardian cases. On their arrival the plants were placed in nurseries, where they were gradually exposed to the full light of the sun, and when about half a metre high they were planted out at intervals of three metres. The seedlings do not stand transplanting so well as the Ceara plants, and they require a more substantial and deeper soil with more moisture. When first planted out they require to be sheltered, and in this particular case it was found necessary to protect them from goats and antelopes which are very fond of the bark. Experiments conducted on land inundated for three months in the year have not given good results in general, though individual trees have shown considerable development under these conditions. The tree attains a height of two metres in the first year, and five in the second, and only branches during the third year at a height of seven or eight metres. Its stem remains very slender for a considerable time; and although this tree at first withstands the wind better than the Ceara tree, it often falls later. To prevent this it is expedient to pollard at a height of one metre about the fourteenth or fifteenth month. *Hevea brasiliensis* does not produce seeds at an early stage, and is propagated by layering on slips; the latter method is preferable, and the slip, which should be as large as possible, is taken from well-seasoned wood.

Castilloa elastica (Central American rubber tree).—Plants of this species have been raised from seed, and also imported as seedlings in Wardian cases, the latter being found the more satisfactory method. In cultivation the same general precautions are necessary as for *Hevea*; the growth is a little slower, but the general development is more proportional, and it may be noted that the plant does not stand pruning well. Propagation by slips has been found impracticable; but layering has given very good

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results. The trees have been planted in an avenue, twelve metres wide, at a distance of five metres from each other.

Funtumia elastica (Lagos rubber tree).—For a long time this tree was confounded with a similar species growing abundantly in many parts of the Congo Free State. Of the latter species, in the belief that it was the true plant, large numbers were propagated. The latex from this is known locally as M'Bolé, and has been found to yield rubber of very inferior quality. The mistake has now been remedied, and specimens of the true *Funtumia elastica* have been introduced. They grow more slowly than the other rubber trees already mentioned, and at the end of six months had not been removed from the nurseries.

Urceola esculenta.—This rubber vine, indigenous to Borneo, has been successfully raised from seeds, which can be transported without damage. The germination was slow, the cotyledons and the first pair of leaves being put forth with great difficulty, after which, however, the young plants began to grow rapidly. At this moment they were transferred to the bases of large trees in the forest, where in three months they attained a height of more than a metre, and have continued to grow well.

In addition to the above rubber trees, specimens of the plant yielding Balata (a gutta-percha substitute) have also been successfully raised from seeds. The latter resemble peach stones in appearance and require to be cut like those of the Ceara rubber tree in order to facilitate germination, which was most readily induced by placing them in moist moss, and protecting them from the attacks of rodents and termites. Treated in this way 28 per cent. of the seeds developed. At the first signs of germination, the seeds were transferred to small pots made of bamboo framework, and in another two months they had rejected their coat and put forth the cotyledons. After the production of the second or third leaf the seedlings were planted out, without being removed from the pots, as the roots are very sensitive and suffer when transplanted. The whole operation requires considerable care, and for several months the young plants need frequent waterings and shelter from the sun.

It will be seen from this summary of the report that the plantation has not yet arrived at the stage at which a definite opinion can be expressed on the value of the different trees, based upon the yield and quality of their rubber; but the information given will prove useful to those interested in similar undertakings.

CULTIVATION OF ECONOMIC PLANTS IN UGANDA.

An account of the economic plants, indigenous and exotic, under cultivation in the Botanic Gardens at Entebbe, Uganda, is given in a recent report by Mr. T. Mahon to the Foreign Office (*Diplomatic and Consular Reports, No.* 588, *Miscellaneous Series*), extracts from which were published in the "Board of Trade Journal" for 5th February. The gardens have only recently been established, but already good work has been done towards the utilisation of indigenous economic plants, and the introduction of others which appear likely to be suitable for cultivation in the country. A list of the plants under cultivation is given in the report, and indicates the varied nature of the introductions, which include several species of rubber trees, cacao, coffee, tea, and a large number of tropical fruits, spices, and timber trees.

In view of the interest which the cultivation of rubber trees is attracting at the present time in almost all tropical countries, it is not surprising to find that this question has already received considerable attention at Entebbe. Species of the African rubber vines (*Landolphias*) are abundant throughout large districts of Uganda. They yield excellent rubber, which was exported for the first time in the year 1901-2, the value of the product being 1,600*l*. Owing to the climbing habit of these vines it is impracticable to systematically cultivate them; moreover, the plants grow exceedingly slowly under cultivation, and resent transplanting, so that in any attempts to rear them it is necessary to sow the seed where the plant is to remain. The exhaustion of these natural supplies of rubber is, therefore, only a question of time, dependent merely on the activity of traders; and it is satisfactory to find that specimens of the chief rubber-yielding trees have already been obtained with a view to the cultivation of those found most suitable for the country.

Seedlings of the Pará rubber tree (*Hevea brasiliensis*), which yields the best rubber of commerce, were obtained from Kew in 1901, and although a very severe drought was experienced at Entebbe immediately after their arrival, some of them survived and are now growing freely, one plant being over seven feet in height and otherwise of proportionate growth. *Hevea brasiliensis* thrives best at low level. It remains to be seen, therefore, whether the climate and elevation of Uganda will suit it, though there is every probability that it will succeed in the neighbourhood of the Lake. The Central American rubber tree, *Castilloa elastica*, has also done very well, and since it grows in its native country, even at considerable elevations, it seems likely to be suitable for cultivation in Uganda. A large number of Castilloa seedlings are being obtained for trials upon a more extensive scale, and attempts are also being made to raise the plant from seed. Another rubber tree

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under cultivation in the gardens is *Manihot Glaziovii* (Ceara rubber), which is growing with its accustomed vigour, a seedling of eight months being nearly four feet high. Opinions vary as to the value of this tree for cultivation, and in some cases the yield of rubber has been so small that it has proved unremunerative. But under favourable conditions the plant yields a very good rubber, and might be suitable for Uganda. The Lagos rubber tree (*Funtumia elastica*), which is a native of the West Coast of Africa, is also being tried, and a number of fine plants have been successfully raised from seed. These were unfortunately lost owing to the burning down of a large nursery shed, but a further supply of seed has been obtained, and the experiments will be continued. A few seedlings of this variety are, on the whole, doing very well.

In order to determine the yield and quality of the rubber furnished by these different trees in their new habitat, experimental tappings will be necessary as soon as the plants are sufficiently mature. The information thus acquired will be of the utmost value in selecting the tree or trees most suitable for cultivation in Uganda.

Of the other plants mentioned in the report, cacao, coffee and tea may be first noticed. Seedlings of cacao (*Theobroma Cacao*), sent from Kew, have been successfully introduced, and after being planted out for nine months they continue to make satisfactory progress. Apparently cocoa is not at present grown upon a commercial scale in any country at such a high altitude, 4,000 feet, so that the experiments at Entebbe will be of considerable interest.

A species of coffee is indigenous to the country. A small plantation of this has been established, and good results are anticipated provided that proper methods of growing the plant and curing the bean are adopted. This native coffee is frequently stated to be *Coffea arabica*, but it is probably a distinct species, and is certainly allied to the large-leaved West Coast varieties; a Congo species (*Coffea obusta*) bears a striking resemblance to it. Besides the above, several other well-known varieties of coffee have been introduced, and the results already obtained with these prove that the country can produce coffee of first-rate quality.

The tea plant grows in the gardens at Entebbe with moderate rapidity, the rainfall being insufficient; but it is stated that large areas in the Ruwenzori country are eminently adapted to tea cultivation on a large scale.

Among the tropical fruits which have been introduced are oranges, lemons, limes, pineapples and bananas; and the cultivation of these is being extended as fast as possible, since fruit is one of the scarcest articles of food in Uganda.

Timber trees are receiving considerable attention. The fine "Mlanji cedar" of Nyasaland has been found very suitable for Uganda, and large quantities of the seeds have been widely

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distributed. Mahogany will be extensively planted, and experiments are being made with a number of other useful timber trees. Owing to the depredations of "white ants" (termites), it has been found practically impossible to establish in the gardens any of the Eucalypti, although a wide selection of species has been tried. It has been noticed, on the other hand, that the guava is not attacked, even when grown in situations in which termites are numerous.

There are several indigenous fibres which promise to be valuable articles of export, and already preliminary steps have been taken with a view to utilising them. Sansevieria (Bowstring hemp) is abundant, and specimens sent to London have been very favourably reported upon, one being valued at 25*l.* per ton. The Raphia palm is very common on the lake side, and large supplies of its fibre are available. Both of these could be propagated to any extent by planters at a trifling cost. The common ramie or "China grass" also occurs, growing well, and many parts of the country appear to be adapted to its cultivation. In addition to these a species of cotton is indigenous, and yields material of a very fair quality, while experiments upon a small scale with imported varieties have given promising results. The only drawback in the latter case has been the tendency of some perennial varieties to become annual, dying off as soon as the crop has matured.

The usefulness of the work which is being done in the Botanic Gardens at Entebbe will be apparent from the foregoing illustrations, and the results of the experiments cannot fail to be of great value in the proper development of the resources of the country.

THE UTILISATION OF WEST INDIAN RAW SUGARS.

Sugars used in brewing are at present obtained chiefly by the hydrolysis of starch, cane sugar and other carbo-hydrates. The possibility of using West Indian raw sugar on an extensive scale in brewing, forms the subject of a paper read before the Agricultural and Commercial Society of Antigua by Mr. F. Watts, Government Chemist for the Leeward Islands, and published in the West Indian Bulletin, Vol. III., p. 199.

The chief sources from which brewers now obtain their supplies of crude sugars and molasses are Egypt, the Philippines and Madras.

It is important that planters should be aware of the fact that the requirements of refiners and brewers are very different. The refiner requires a sugar free from glucose. The brewer, on the contrary, buys glucose, cane sugar, and indeed sugar in any form,

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even in the potential form of starch, provided that these materials are free from dirt, from unfermentable substances, and from unpleasant flavouring matters such as occur in unrefined beet sugar.

Good muscavado molasses containing about 53 to 55 per cent. of cane sugar, 12 to 14 per cent. of glucose, and 18 to 20 per cent. of water, and having no defect of colour or flavour, would be very acceptable to brewers, but the price must compete with that of sugar derived from cheap starch. Molasses are cheap, but being fluid they require a form of packing that is expensive. It is therefore desirable to ascertain whether some less expensive method can be devised with a view to diminishing the cost and increasing the use, by English brewers, of West Indian molasses. The author suggests that it might be possible to export "massecuite" (undrained raw sugar) in the form of "concrete."

It is immaterial to the buyer whether the article is solid, pasty or fluid, as the value depends not upon the physical condition, but upon the quantity of cane sugar and glucose it contains. The physical condition, however, makes a great difference in the cost of transport, and it would be well for planters to ascertain by means of a few experiments, whether they can produce "concrete" sufficiently solid to permit of shipment in bags.

It is suggested that the planters in the West Indies should be kept fully informed of the markets for molasses and "concrete" so that they may take advantage of any opportunities that may be afforded by abolition of the sugar bounties, or by other changes.

CASSAVA AS A SOURCE OF STARCH AND ALLIED PRODUCTS.

A paper contributed by Dr. Geo. Archbold to the Journal of the Society of Chemical Industry, Canadian Section, 1903, p. 224, discusses the possible utilisation of the roots of the Cassava plant as a source of starch.

Two varieties of the Cassava plant are known, *Manihot utilissima* producing sweet cassava, and *Manihot palmata* producing bitter cassava. The juice of the latter contains ·5 per cent. of prussic acid, which however can be dissipated by the application of heat. The plant is indigenous to the West Indies, but has been introduced into many tropical countries, including India, and is now extensively cultivated for its starch, which, in the form of tapioca, is a staple article of export.

From the results of over 100 analyses of cassava roots grown in Jamaica, it was found that the average amount of dry starch

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obtainable from fresh roots was 26·23 per cent. The following typical analyses may be quoted:—

——	Fresh Root.	Dry Root.	Flour.
Water	66·748	5·170	·560
Proteid matter	·855	2·455	1·310
Fat	·188	·525	1·580
Resins and alkaloids	·115	·325	·640
Amides and sugars	5·650	16·090	6·540
Crude fibre	1·685	4·800	2·960
Starch	24·075	68·530	84·630
Ash	·740	2·105	1·860
Potash	·300	·860	—
Phosphoric acid	·080	·235	—

These figures justify the belief that 25 per cent. of starch could be obtained from the fresh roots by proper mechanical means, whilst from maize 53 per cent. and from potatoes 18 per cent. of starch is obtainable. An acre of ground will give 40 bushels of maize, yielding 1,200 lbs. of starch; whilst the same area will give 10 tons of cassava, yielding 5,600 lbs. of starch. It is stated that even heavier crops are produced in Florida.

In Jamaica, where the plants grow all the year round, it is estimated that 20 tons of cassava per acre could be obtained by proper cultivation, or nearly ten times the amount of starch per acre yielded by maize. Should the cultivation of cassava on a large scale be attempted, the cheap labour and other advantages possessed by Jamaica would be important factors in determining the production of starch at a low price, and it may be noted that the Elder, Dempster Company have started an experimental plantation in the island. The opinion is held that Great Britain, with her important tropical possessions, many of which are eminently adapted to the cultivation of cassava, could become one of the largest producers of starch and allied products. Cassava flour, it is stated, could be extracted and shipped to manufacturing centres at a cost considerably lower than the lowest price of maize.

Furthermore, it is pointed out that the extraction of starch and glucose from maize is tedious and costly, whilst in the case of cassava the process is simple and cheap, and the resulting products are purer.

The quantity of starch per acre obtained from the three crops furnishes a basis for estimating their relative value to the starch manufacturer. With maize at about 45 cents per bushel in Chicago, crude maize starch costs 1½ cents per lb.; with potatoes at 50 cents per bushel the unmanufactured starch is 5 cents per lb.; while, from a crop of cassava yielding 8 to 10 tons per acre (as at Lake Mary, Florida), where the only complete

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cassava starch factory in existence is situated, the starch costs ½ cent per lb. in the manufactured state. If the foregoing estimates should prove to be correct, it is clear that maize would not be able to compete with cassava as a source of starch.

A special method of manufacture has been adopted, for particulars of which the original paper should be consulted.

CULTIVATION OF ALOE FIBRES.

M. Ch. Rivière has given in the "Journal d'Agriculture Tropicale" (January, 1903) a short account of the climatological distribution of aloe fibres under culture.

For hot and damp tropical regions, *Furcræa gigantea*, "Mauritius hemp" a species remarkable for the length of its fibre, is especially indicated. In moderately hot countries in which the summer heat is prolonged and the thermometer rarely falls to zero, the Mexican plants are to be preferred; the variety most exploited is "Sisal hemp" or "Henequen" (*Agave rigida*). In elevated regions where the heat is prolonged and the rainfall small, but where cold is sometimes experienced, the Tampico hemp (*Agave heteracantha*) is the most suitable plant on account of its comparative hardiness. Finally, *Agave americana* and *Agave mexicana* can be cultivated in almost any climate except those in which frost is common and protracted.

COTTON CULTIVATION IN ASIA MINOR.

The cultivation of cotton was introduced into Asia Minor, from India, in comparatively early times; but it was not until the end of the eighteenth century, when the saw gin was invented, that in Vilayet Aidin the industry first became of importance. At that period considerable quantities of cotton (in 1787, 5,700,000 lbs.) were exported to England. The production of cotton in Asia Minor reached its maximum during the American Civil War (1861–1864). Before the American crisis the quantity exported from Smyrna had been for some years about 15,000 bales per annum; but in 1862 it rose to 62,000 bales, and in the following year the area under cultivation in some districts increased tenfold. The district of Aidin alone must at that time have produced 80,000 bales. Subsequently the price of cotton and its production declined.

The question of the feasibility of extending the cultivation of cotton in Smyrna with the help of German capital has been studied

Cotton Cultivation in Asia Minor.

recently by Dr. Rud. Endlich, whose experiences and conclusions are published in the "Beihefte zum Tropenpflanzer" (December, 1902).

At the present time, the cultivation of cotton in Western Asia Minor is limited to the four valleys opening towards the Ægean Sea. The total amount carried by the Smyrna railways in 1901 was about 36,000 bales.

The cotton plant which has proved best adapted to the primitive style of cultivation of Western Asia Minor is the variety of *Gossypium herbaceum* (the species originally introduced from India) known as "Yerli" (*i.e.* native). Neither the Sea Island cotton imported at the time of the American civil war nor the Upland cotton which was introduced at a later date have been able to assert themselves to any considerable extent; during the year 1901 the production of American cotton in the neighbourhood of Aidin only amounted to 36,000 lbs.

It has been alleged against the American cotton (1) that its collection demands much more labour than that of the "Yerli," (2) that in consequence of its longer period of growth a greater risk is incurred than in the case of the native variety, and (3) that it degenerates very rapidly in Asia Minor, an inequality and diminution in length of the staple being to some extent noticeable even at the first harvest.

With regard to the harvesting operations, it is true that the "Yerli" requires less work than American cotton. The cause of this lies in a peculiarity of the "Yerli" capsule, which encloses the seeds and fibre so firmly that the whole fruit must be plucked. This peculiarity gives the fibre the advantage of protection from adverse climatic influences, and consequently the collection can be made at longer intervals, whereas the American cotton must, during the harvest, be gathered at least every second day. The "Yerli" cotton, which ripens more quickly and regularly than the perennial varieties, may usually be collected in two or three operations; but it sometimes happens that this work must be done four or five times; on the other hand, in some cases the whole crop may be collected at once. This convenient method of harvesting, however, involves the disadvantages that some of the fibres develop a faulty structure, and that the value of the cotton collected is diminished by the presence of fragments of capsules, sand, &c. Finally, if the work of separating the cotton from the capsules is included as a part of the harvesting operations, the advantage of the native over the American cotton is not so great as would appear at first sight.

Although the greater trouble involved in the collection of the finer varieties of cotton is compensated by the higher price which is obtained for them in the market, yet their longer periods of growth are decidedly disadvantageous as thereby the fibre is

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rendered more liable to injury by the heavy rains which occur in Vilayet Aidin in October and November.

Small importance should be attached to the alleged degeneration of the American cotton. The want of success hitherto is attributable not so much to climatic conditions as to neglect in cultivation, and repeated mixing of the seed.

The results which, in spite of the primitive methods of cultivation, have been obtained in Vilayet Aidin with *Gossypium herbaceum*, prove that the climate is well adapted to the growth of this variety; no final judgment, however, can be formed at present with regard to the other varieties. The conditions of temperature are similar to those of the northern American cotton states. The cotton bush flourishes best on alluvial soil; the flood deposits of the river valleys and coast districts with relatively high sand content are particularly beneficial. But heavier soils, rich in humus, of older or more recent alluvium, appear to be also suitable if they contain a moderate proportion of lime and potash. The cotton plant can be grown with success on any soil, from a medium or heavy loam, even to a light sand, if, in addition to the necessary chemical constituents, plenty of moisture is present; but an impermeable soil such as heavy clay is quite unsuitable. In Vilayet Aidin, owing to the lack of rain during the summer months, as a rule only the fertile river lands are devoted to the cultivation of cotton.

The cotton harvest begins about five months after sowing. The upper capsules ripen first and yield the best quality of fibre and seed (the so-called "top-crop"), while those collected at the end of the harvest (November) have the lowest value. The fibres of the late-gathered capsules are inferior both in structure and colour; if, as is often the case, all the capsules are collected in one operation, a considerable loss is sustained. The more intelligent cotton planters therefore usually collect the capsules on from two to five occasions. The cost of gathering the capsules is very small, since it is done by women and children.

During its period of growth, the cotton plant in the fertile river valleys of Asia Minor is less influenced by the weather than are most other cultivated plants; for during the stormy season, injurious to the vines, cereals and tobacco, and usually extending from the middle of May to the middle of June, the young cotton bush suffers no harm. It is also uninjured by the protracted drought, which occurs during the later stages of growth, since its long tap-root finds abundant moisture in the sub-soil. If, however, rain falls continuously during the season of harvest, the crop, even of the comparatively hardy "Yerli," deteriorates.

The cost of production and the yield per hectare have been carefully worked out, and it has been found that an average yield of 300 kilogs. of clean cotton and 900 kilogs. of seed involves an outlay of 990·80 piastres and realises 1,571·0 piastres, leaving a net profit of 580·20 piastres per hectare. It follows from these estimates that in Vilayet Aidin the production of 1 kilog. of cotton costs about 3 piastres (apart from the value of the seed obtained), whereas the cost of production on the United States experimental station only amounts to 2·5 piastres per kilog., with a higher net profit (861 piastres). There is no doubt, however, that by the employment of more modern methods of cultivation, and by careful harvesting, the yield and quality of the cotton grown in Asia Minor could be greatly improved.

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INFLUENCE OF CERTAIN CHEMICAL REAGENTS ON THE TENSILE STRENGTH AND DYEING PROPERTIES OF COTTON YARNS.

The tensile strength of cotton yarn for practical purposes is usually determined by stretching a lea of the yarn between two steel hooks or arms, and then ascertaining the weight required to draw the arms apart and break the lea. In a paper contributed by Messrs. Hübner and Pope to the Society of Chemical Industry ("Journ. Soc. Chem. Indust.," 1903, 70-77) it has been pointed out that this method is unsatisfactory, as it is not possible so to spread the lea between the two arms as to ensure an equal distribution of the stress among all the threads; the lea is gradually torn, some threads breaking before others, owing to the fact that they receive more strain, and the breaking load registered is less than the sum of the breaking loads of the individual threads. These discrepancies are avoided by a more accurate method —that of the tearing machine described by Dalén. A single thread loaded with a weight of two grams in order to keep it straight is held between two clips fixed at a definite distance apart; a simple hydraulic device increases the weight of the load at a uniform speed, so that the clips are pulled apart gradually and without any sudden jerk. In order to ascertain the mean tensile strength with some degree of accuracy, 100 threads were broken in the examination of each specimen.

The material used for these experiments was uniformly spun, two-fold, 50 Egyptian yarn. By boiling a portion of this with 1 per cent. solution of sodium carbonate the tensile strength was increased; this change, however, appears to have been due to the boiling water, and not to the action of the sodium carbonate, since it was found that a 15 per cent. solution of sodium carbonate caused no greater increase in the tensile strength than the 1 per cent. solution.

Determinations of the tensile strength of the yarn, made by diminishing the distance between the clips in the tearing machine to 1 millimetre, so that the yarn was broken in lengths of 1 milli-

Influence of Certain Chemical Reagents.

metre instead of in lengths of 100 millimetres as in previous trials, showed that the very short lengths gave a much higher tensile strength.

Attention was next directed to the influence of "mercerisation" on the tensile strength; the yarn was scalded for two minutes in boiling water and left, one portion for 24 hours and another portion for six days, in caustic soda solution of specific gravity 1·342. In both cases a considerable increase in tensile strength took place, and the experiment also showed that the greater part of this increase was brought about during the first 24 hours; but it was evident that after the first day the effect of the alkali on the yarn was very small.

The interesting observation was made that potassium iodide has superficially much the same effect upon cotton as has caustic soda. If saturated solution of potassium iodide is poured upon reeled yarn the bank "wets out" immediately just as with caustic soda, the fibres becoming transparent and assuming a glassy appearance; the rapid penetration of the cotton by the solution is accompanied by appreciable shrinkage of the fibre, the tensile strength being simultaneously increased. That treatment with potassium iodide solution and "mercerisation" have similar effects upon cotton is further indicated by the fact that in each case the product has a far greater affinity for direct cotton colours than has the untreated yarn. By further experiments it was found that barium iodide, potassium mercuric iodide, and barium mercuric iodide produce changes in the yarn similar to those brought about by the action of potassium iodide.

In view of the similarity in the behaviour of cotton yarn towards caustic soda and iodides, it seemed desirable to ascertain the effect produced upon the tensile strength of mercerised yarn by treating it with a saturated solution of potassium iodide; it was found that although potassium iodide causes a considerable increase in the strength of the raw cotton yarn, it effects an appreciable reduction in that of mercerised yarn. The strength of the latter is also diminished by the action of boiling water, whereas the strength of the raw cotton yarn is increased by this treatment.

The authors consider it highly probable that the twist is the controlling factor in determining the strength of a yarn, and show that in one and the same yarn the strength is directly proportional to the twist. The value of a yarn for manufacturing purposes must be to a considerable extent dependent upon the uniformity of its twist; that is to say, a yarn which will withstand the various operations of bleaching, "mercerisation," dyeing and weaving, without giving great trouble owing to frequent breakages, must be one in which the limits of the tensile strength, measured on about 100 separate threads, do not lie too far apart.

Bulletin of the Imperial Institute.

CATALYTIC MANUFACTURE OF SULPHURIC ACID.

With the exception of the smelting of metals, almost all manufactures that involve chemical operations make use, either directly or indirectly, of sulphuric acid. Sulphur and the mineral known as iron pyrites, a compound of iron and sulphur, are easily burnt, the sulphur combining with the oxygen of the air to form the gaseous compound sulphur dioxide SO_2; but before sulphuric acid can be obtained the sulphur dioxide must be made to combine with a third atom of oxygen from the air. The method of effecting this union, employed since 1740, has been the use of oxides of nitrogen as carriers of the oxygen from the air to the sulphur dioxide.

Recently, however, another method of effecting the union, known as the "catalytic" or "contact" method, has been employed on the manufacturing scale. It consists in the use of certain solid substances which have the property of causing the combination of sulphur dioxide and oxygen. The action takes place at their surfaces, while they themselves form no permanent compounds with the gases that pass over them. Platinum in a finely divided state is one substance that can be used, but it has been found that ferric oxide, a far cheaper material, can also bring about the oxidation. The sulphur trioxide thus obtained instead of being mixed with the proportion of water necessary to make ordinary sulphuric acid, is used to prepare a sulphuric acid containing a large excess of sulphur trioxide. This fuming acid is of especial use in the manufacture of dye colours.

The conditions which determine the efficiency of ferric oxide as the "contact" agent have been investigated by Messrs. Lunge and Pollitt, and the results of their experiments are published in the Journal of the Society of Chemical Industry, 1903, p. 79. They studied the following five points in relation to the action:—(1) The influence of the degree of dilution of the gases. (2) The influence of moisture. (3) The quantitative reacting power of the contact substance in bringing about the combination of the gases. (4) The influence of temperature. (5) The influence of different additions to or impurities in the contact substance.

In their experiments a mixture of pure sulphur dioxide gas and air was employed; on the manufacturing scale the gases from the furnaces generating the sulphur dioxide would also contain the residual nitrogen of the air which had been used to burn the sulphur. The ferric oxide used in the first experiments was prepared by precipitation, and then dried by very gradually raising the temperature to a red heat; it was brick red in colour and was in small pieces.

As regards dilution of the reacting gases, it was found that when

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the sulphur dioxide amounted to from 2½ to 12 per cent. of the total volume of the mixture of sulphur dioxide and air, the proportion of the total sulphur dioxide oxidised to SO_3, varied but little from 38 per cent. A still more diluted mixture would probably act equally well, but if the sulphur dioxide exceeded 12 per cent. the proportion oxidised rapidly fell off, and the contact action of the ferric oxide was impaired for a time, so that it would not oxidise even dilute mixtures so well as before.

In these experiments the temperature was 680°–700° Centigrade, but it was found that somewhat lower temperatures, namely, 600°–620° C., gave better results, 47 per cent. of the sulphur dioxide being oxidised. Below 600° C. only very small quantities of sulphur trioxide were formed; between 620° and 750° C. the proportion was 38 per cent., above that point the proportion fell still lower.

Moisture was found under ordinary conditions to be a "poison" to the contact action. The mixture of gases should be made as dry as possible by thorough treatment with sulphuric acid, which is a powerful desiccating agent. Neglect of this precaution not only causes the "contact" action to be at once much diminished, but, in addition to this, the contact mass has to be treated for a long time with the dry mixture before it recovers from the "poisoning" action of the moisture. If the ferric oxide is exposed to ordinary air, it absorbs some moisture and is thereby similarly "poisoned," and requires a prolonged treatment with dry gases at red heat to enable it to recover its maximum catalytic action.

An improvement of the contact action by methods of treatment having for their object the loosening of the surface of the oxide of iron was not achieved. Oxides obtained by heating ferri- or ferrosulphate gave a much feebler action than that obtained with an oxide prepared by igniting precipitated hydroxide of iron, or in the form of pyrites cinders.

On the manufacturing scale the source of the oxide of iron is always pyrites cinders, and, therefore, experiments were made employing such material, which had been exposed for some time to air, and consequently had absorbed moisture. The experiments showed that at first ferric oxide, in the form of pyrites cinders, is a very bad catalytic agent, but by prolonged use it attains the same maximum of contact action as was reached by the ferric oxide first employed. It appears to retain stubbornly a little water, which acts as a contact "poison," and which is gradually driven out.

In the manufactory flue dust is likely to accumulate in the contact substance; it consists chiefly of oxide of iron, but also contains arsenic, combined as oxide, which, in the case of platinised asbestos contact substances, is one of the worst "catalysis poisons." The action of arsenious oxide on the efficiency of ferric oxide was there-

Catalytic Manufacture of Sulphuric Acid.

fore studied, and instead of being prejudicial it was found to increase the efficiency. Arsenious oxide is completely taken up and retained by oxide of iron at a high temperature. The best temperature for this purpose seems to be not less than about 700° C. The oxide of iron can be thus charged with arsenic up to considerable quantities. An oxide thus charged, if it contains 2¾ per cent. of arsenic (reckoned as elementary arsenic), shows a very considerably increased contact action (over 60 per cent.) in comparison with the pure oxide. Copper oxide is contained in many pyrites cinders, and therefore some cinders from Rio Tinto, containing 3·1 per cent. of copper, were experimented with, and it was found that the presence of copper oxide was favourable to the oxidation of the sulphur dioxide, and also that if this oxide of iron containing copper oxide was charged with arsenious oxide there was a distinct increase of contact action.

THE DIAMOND DEPOSITS OF SOUTH AFRICA.

Although diamonds have been found chiefly in river sands and gravels or conglomerates, their occurrence in these secondary deposits throws no light upon their origin. In South Africa they were originally discovered in the gravels of the Vaal River; subsequently, however, they were found in far greater quantities in the dry diggings, which are huge vertical pipes of unknown depths.

Concerning the origin of these pipes different opinions have been held. Now that the workings have reached lower depths more correct information has been obtained with regard to the formation in nature of this precious stone. A paper recently read by Mr. Heneage before the Institution of Mining and Metallurgy, forms an interesting contribution to our knowledge of this subject.

The diamond mines are situated on a plateau about 4,000 ft. above sea level, covered with a red sandy soil, resting upon a bed of diabase stretching across the whole area. The deposits are in the shape of huge pipes, each several acres in extent, and pass through the following strata:—(1) Red sandy soil 1 ft. to 5 ft.; (2) Diabase, much decomposed, 20 ft. to 90 ft.; (3) Black Kimberley shales of a bituminous nature, 200 ft. to 250 ft.; (4) A conglomerate about 10 ft. thick; (5) Diabase or melaphyre (the bed rock of the Vaal River diggings) about 400 ft.; (6) Quartzite about 400 ft.; (7) Metamorphic slates with thin layers of sandstone; (8) Quartzite. The bedding of the various strata is horizontal, but the edges of the shales at the sides of the "pipes" are bent upwards at an angle of about 40 deg. for a distance of 3 ft. The faces of the harder rocks are polished and striated in various

The Diamond Deposits of South Africa.

directions, mostly at an angle of 45 deg. to the vertical, and some of the scratches have apparently been made by descending bodies. There are no signs of fusion. The material with which the pipes are filled is of a steatitic nature, with a brecciated appearance and of a pale bluish or greenish colour altered to yellow in the first 50 ft., where it has been subject to atmospheric influences. In the upper part the material has the consistence of clay, while lower down it becomes gradually as hard as limestone. It is full of well-rounded boulders, many of which are of immense size, some of them having been evidently derived from the rocks through which the pipe passes. There are also innumerable crystalline fragments, and it is estimated that 15 tons weight of diamonds have been obtained. The composition of the matrix appears to be the same in all cases, but each mine has its own particular kind of diamond. Some authorities consider that the rock is a true igneous lava; but the diamonds would sc[illegible]ly survive the fierce heat of volcanic fusion, while their [illegible] condition seems to preclude the supposition of their havi[illegible]n formed *in situ*.

According to present knowledge it seems possible that the pipes have been burst open by the force of gas or superheated steam perhaps in a former sea near the edge of the Karoo basin, and that for a time they were geysers which gradually became intermittent mud springs of continually increasing viscosity till at length they ceased to be active. The diamonds were probably formed from accumulations of carbon-dioxide under enormous pressure and at a comparatively low temperature. Each pipe would under these circumstances produce its own kind of diamonds according to the surrounding conditions. An eruption would bring the diamonds to the surface and churn them up with the matrix of the pipe. Their anomalous optical characters and the broken condition of many of the diamonds could be satisfactorily explained by this theory.

GEOLOGICAL NOTES ON THE IVORY COAST.

The importance of gold-bearing deposits to a country has been well illustrated by the rapid development of several British Colonies, and it cannot be doubted that the discovery of this metal in territories now almost unknown would do much towards bringing them within the scope of industrial enterprise. In a paper read before the Institution of Mining and Metallurgy (Proceedings 1902-1903), Messrs Truscott and Samwell have shown that gold occurs on the Ivory Coast not only as an alluvial deposit

Geological Notes on the Ivory Coast.

but also in quartz reefs, though hitherto practically nothing has been done to work it. The gold-bearing area extends from the River Comoe on the west to the British frontier on the east. Archæan rocks, consisting of granite, diorites, gneisses, and crystalline schists form the basement of this area, and there is a marked absence of sedimentary rocks, in place of which exists an interesting fragmentary formation so shallow that the basement rock is frequently exposed in the stream beds. Capping the hills, which sometimes attain a height of 800 feet, is a ferruginous agglomerate which appears to be of volcanic origin. Under this there is frequently a yellow sandy or clayey deposit of an average depth of 50 ft. Gold is found in three forms: (1) reef gold, (2) detrital gold in the fragmentary formation, (3) alluvial gold in the stream beds. The quartz reefs occur throughout the basement rock, and vary greatly in thickness at their outcrops. Very little work has been done in this district, and the attempts made by the natives to work the reefs have not proved very successful, most of the gold so far obtained having been derived from river sands.

THE MICA DEPOSITS OF INDIA.

The great increase which has taken place in the last few years in the consumption of mica, notably for electrical insulation, has given an impetus to mica mining, especially in India. For this reason interest attaches to a complete survey of the valuable mica deposits of that country recently made by Mr. T. H. Holland, the results of which have been published in the Memoirs of the Geological Survey of India (1902, Vol. 34, part 2).

Valuable mica occurs in the granite pegmatites in which the constituent minerals have crystallized on a large scale, and is found associated with mica schists, quartzites and other rocks of the upper division of the Archæan group; into the schists the pegmatites have been intruded, generally along, but sometimes across, the folia, in the form of thin sheets, lenticular bodies, or large thick masses. The tendency of the pegmatite sheets to follow the planes of foliation is probably due to the fact that this is the direction of least resistance in schistose rocks. Being the most delicate mineral in the rock, mica is the first to show deterioration as a result of earth movements; and it is due to the exceptional quiescence the Indian Peninsula has enjoyed during long geological periods, that it contains the finest mica deposits in the world.

In Bengal, the mica producing area roughly coincides with a great belt of schists and associated gneissose granite about 12 miles broad, stretching from Bendi in the Hazaribagh district, through the south-eastern corner of the Gaya district, east-north-eastwards to near Nawadih (Jha-Jha) on the East Indian Railway in Monghyr. Along this belt mines exist, turning out annually about 450 tons of mica, valued at 9 lakhs of rupees. The schist belt forms an irregular scarp, and the comparatively rapid erosion by the river has opened up the country and facilitated both the detection of pegmatite veins and the mining operations. Up to the present time the mining has been superficial. and there is no likelihood of an early exhaustion. Besides mica, other valuable minerals are occasionally found.

In the Bombay Presidency mica has not been mined, but several outcrops of mica-bearing pegmatites are known to occur. In Burmah the only locality in which the mineral has been obtained is near Aje-nya-a, where mining leases have been granted.

The district of Coorg, in the Central Provinces, is occupied by a complex group of schists, similar to those in which mica is found in Bengal. Pegmatite veins occasionally traverse these schists and have been found to carry muscovite, which, although excellent as regards freshness and elasticity, often shows signs of having been warped and damaged by pressure.

The mica district of Nellore, in the Madras Presidency, consists of a central V-shaped fundament of well-foliated gneisses. The schists which contain the mica-bearing pegmatites extend from the fourteenth to the fifteenth parallel of latitude north, and from Nellore westward a distance of 30 to 40 miles. The largest mica crystals found in India have come from this mining district, some from the Inikurti mine measuring 10 ft. across the basal planes and 15 ft. across the folia; and rectangular sheets perfectly free from cracks and flaws, measuring 30 ins. in length and 24 ins. in breadth, have been obtained.

Mica-bearing pegmatite occurs in various localities in South-west Wainad, chief among these being Gudalur, Devala, Nellakota, Pandalur and Cherambadi. The best mica has been found in the neighbourhood of Cherambadi, where it is ruby-coloured and of high quality. The total thickness of the pegmatite band seldom exceeds 8 ft., and at present the workings have only reached a depth of a few feet below the surface.

The State of Mysore is, geologically, composed entirely of crystalline and transition rocks, through which, in places, pegmatites are intruded, occasionally bearing mica of marketable quality. Mica is also found at Sirolu, in Rajputana, and at Jaipur, Kishengarh and Tonk.

The localities which appear to be most promising as mica mining centres are in the neighbourhood of Mysore, Attikuppa and Yelawal.

Bulletin of the Imperial Institute.

THE ASPHALT INDUSTRY OF TRINIDAD.

The chief mineral industry of Trinidad is the mining of asphalt, which occurs in large deposits in the north-west parts of the island. In 1878, the quantity exported was 7,848 tons; since that date the demand for asphalt as a paving material has rapidly increased, with the result that the output from the island in 1900 amounted to 158,752 tons. In 1888, a concession to mine asphalt was granted by the Crown to the Trinidad Asphalt Paving Company, Ltd., of New York, with a guarantee that no further grants should be made of Crown lands within a radius of three miles. The remaining mining lands were comparatively small in extent, and consequently became very valuable, and at present there are only three other large landowners in the asphalt-mining village of La Brea. There, private owners have won asphalt to some extent from their properties, but disputes have arisen between them and the American company, with the result that 29 cases of litigation have occurred since 1899. These difficulties are mainly attributable to a peculiar property which asphalt, like most semi-viscous substances, has of flowing slowly under pressure: the deposit of land pitch occurs in one long channel, and extraction from one part causes a flow from the vicinal asphalt, with a consequent deterioration of the value of the whole deposit. A Royal Commission was thereupon appointed by the Secretary of State for the Colonies in 1902 to conduct an enquiry into all matters concerning the asphalt industry at La Brea.

The report of this Commission is now available, and from this source the following abstract, dealing with the asphalt deposits of the island, is compiled.

The asphalt deposits in the district of La Brea are of two kinds: one, known as "lake pitch," lying within the so-called pitch lake, and the other known as "land pitch," lying outside the boundary of the lake. The area within which land pitch occurs is spoken of as "pitch lands." These pitch lands lie to the north of the pitch lake, the most important of them known at present lying in a narrow belt extending from the lake first in a north-easterly direction, and almost due north to the small promontory called Pointe La Brea. This belt is about one mile in length, and has an average width of rather more than 150 yards. Upon the northernmost portion of it stands the village of La Brea, and the area therefore is sometimes alluded to as the village lands. The pitch lake is situated on the northern side of a low ridge known as Vessigny Hill, rising to 200 ft. above the sea level. The distance from the western edge of the lake to the sea is only about half-a-mile, the distance to the north being considerably greater.

The lake itself presents the appearance of a flat field of asphalt some 6 to 9 ins. higher in the middle than in the surrounding

The Asphalt Industry of Trinidad.

portions, about 130 ft. above sea level, approximately circular in form and about half-a-mile in diameter. Near the edges it is covered with a thin deposit of soil that supports a luxuriant growth of rank grasses; and similar grassy patches on the lake itself are spoken of as islands. The total area of the lake is about 127 acres; it lies in a well-marked basin showing a rim 3 to 8 ft. in height all round it. The rim has only been rendered visible by the mining operations which have reduced the level of the lake; even as late as 1886 no rim was visible. The surface of the lake is intersected by numerous shallow channels, in which rain water accumulates and has to be drawn off by means of trenches cut through the rim. Owing to the mobile nature of the asphalt the position and dimensions of these channels are constantly changing. The water in the dry season is slightly saline and contains a notable proportion of sulphates; in several places there are small blowers of gas. The central part of the lake is softer than the remainder. It is nowhere, however, in a liquid or even semi-fluid condition.

All the lands between the Pointe d'Or lagoon on the east and the Pointe Rouge on the west, contain asphalt deposits of large or small size; these deposits resemble each other, but differ from the asphalt of the lake in that the asphalt of the lands is harder and drier, and generally contains more earthy matter. These deposits of land asphalt have been exploited in various places, the most important being the already mentioned belt upon which the village of La Brea is situated. Its boundaries are fairly accurately known, but of the others it can only be said that another belt extends north-eastwards into the Pointe d'Or lands along the sea-shore, although perhaps it is not continuous throughout. Other similar deposits are known to exist on the Brighton estate, but nothing is really known as to their importance. It has been shown by borings recently made by the Commissioners that the deposits in the village lands occupy an irregular channel which gradually deepens towards the centre and there attains a depth of 50 ft. In every case in which a boring was made there was found beneath the asphalt a bed, from 3 to 15 ft. thick, of clay intermixed with more or less asphalt. In one bore hole indications of peaty matter were met with at a depth of about 80 ft. Near Pointe Rouge, west of the lake, there is a small spring of asphalt oil, but the amount flowing from it is insignificant. It appears, however, that where exposed to the air this oil thickens and forms a substance resembling the lake asphalt.

The geological structure of all this asphaltic region is extremely obscure. The country rock consists apparently of a soft brown clay shale, usually very sandy, but containing in places beds of a purer clay. It seems probable that these shales are almost horizontal, and have gentle undulations.

The Asphalt Industry of Trinidad.

The asphalt dug from the lake presents exactly the texture and structure of fresh Gruyère cheese, is dark brown in colour, is not lustrous, and has an earthy fracture. The land asphalt occurs in three forms known by the diggers as "cheese pitch," "slate pitch," and "iron pitch" or "rock pitch." Cheese pitch resembles lake pitch in appearance, but is a little harder and blacker; slate pitch is cheese pitch in which the bubbles have become flattened by pressure so that the mass has a laminated structure. Rock pitch or iron pitch is asphalt that has been melted by heat. The natural asphalt melts at temperatures varying from 110° C. to 150° C., but it begins to soften perceptibly at 51° C. to 54° C., whilst some of the varieties of asphalt are soft at so low a temperature as 5° C. Like all viscous bodies the asphalt flow slowly under the pressure of its own weight, the rate of flow increasing with the increase of pressure and temperature. At the temperatures ordinarily prevailing at La Brea it may be won by means of a pick, and may be readily broken with a light blow. In mass, however, it will at the same temperature flow under its own weight, the mean hydraulic gradient observed for natural land asphalt being about 1 in 10. Heated in the open air it takes fire at 200° to 250° C., leaving, when completely burnt, a brownish coloured ash.

Various theories have been put forward from time to time to account for the existence of these deposits of asphalt, and the generally accepted view is that the asphalt was originally present in the form of asphaltic oil within the bed of brown shale already referred to, and that the oil percolated into certain subterranean reservoirs which, by the ordinary course of slow elevation of the ground, together with subaerial denudation, were gradually exposed to the atmosphere on reaching the surface, where inspissation took place, forming the present asphalt deposits. An obvious difficulty in the acceptance of that theory of the genesis of asphalt lies in the fact that an examination of the chemical composition shows that asphalt contains about 5 per cent. of sulphur as an essential constituent. It has been supposed that the channels in which the land deposits lie were formerly beds of a river which flowed over the site of the lake, and by its erosive action cut through the strata overlying the then semi-fluid asphalt laying bare the asphalt, which thereupon escaped into the channels If this view is correct it follows that the amount of asphalt both in the lake and the land deposits is strictly limited, and that mining will lower the surface level of the deposits, the fall of level corresponding to the amount of pitch extracted. The amount extracted from the lake since 1893 is about 1,000,000 tons, and the surface has an area of about 127 acres. Taking asphalt *in situ* at 30 cubic feet to the ton a fall of one foot would be equal to 1,450 tons per acre, and for the whole area of the lake 203,000 tons. During

The Asphalt Industry of Trinidad.

the above period the fall has been about 4·75 feet, corresponding to an extraction of about 874,000 tons. The total extraction from the land pitch deposits in recent times has been about 300,000 tons.

The total amount of asphalt still available in the lake cannot be precisely estimated, owing to lack of definite data. The depth of asphalt in the lake is said to extend beyond 138 ft., possibly, even, to 150 ft. Assuming that this is the case. and that the deposit has approximately the shape of a segment of a sphere, it will follow that the lake contains about 15,000,000 tons. If the depth throughout the village deposit be assumed to average 30 ft., its area being 70 acres, it should contain some 2,000,000 tons.

The following results are from analyses made by Prof. Carmody (Appendix VIII.) :—

Composition of asphalt and earth.

——	Water.	Ash.	Bitumen.	Other Organic Matter.
Lake, soft	29·04	24·12	45·60	1·24
„ ordinary	26·04	27·52	42 00	4·44
„ „	32·04	25·64	35·20	7·12
Iron pitch	·80	40·08	52·80	6·32
Brown earth	15·00	69 56	3·60	11·84

Comparative action of solvents on the bitumen.

——	Total Bitumen soluble in Carbon Disulphide.	Soluble in Petroleum-Ether.	Per cent. of Total Bitumen soluble in Petroleum-Ether.
Lake, soft	45·60	24·00	52
„ ordinary	42·00	21·60	51
„ „	34·20	18·00	51
Iron pitch	52·80	25·60	48
Brown earth	3·60	1·60	44

Results of fractional distillation.

——	Below 150° C.		150°–300° C.		Above 300° C		Cake and Ash.	Loss.*
	Water.	Oil.	Water	Oil.	Water.	Oil.		
Lake, soft...	9·0	1·0	0 5	8·5	—	15·0	39·0	27·0
„ ordinary	6 5	0·7	4·5	2·8	—	14·5	41·0	30·0
„ „	11·0	1·5	8·0	5·5	4·0	8·0	43·0	19·0
Iron pitch	1·0	0·7	0 0	4·8	—	19·0	58·0	16·5
Brown earth	4·0	—	2·0	—	2·0	2·5	76·0	13·5

* This consists of uncondensed gases and steam.

The Asphalt Industry of Trinidad.

The recommendations made by the Commission with a view to the permanent and satisfactory adjustment of the relations between the Colonial Government, the concessionaires and other parties interested comprise:—(1) The codification of the established usage of pitch digging and its regulation under the inspection of an Inspector of Mines appointed *ad hoc.* (2) A re-survey of the village lands, and the establishment of fixed points of reference, such survey to be given the force of law. (3) The establishment of a Sanitary Authority, with adequate powers, in the village of La Brea.

The object of the regulations suggested for the control of asphalt digging is to allow the owner of pitch lands to win as nearly as possible all the asphalt which may be within his land without at the same time unduly depleting the lands of his neighbours. Such depletion is rendered evident by the depression produced in the adjoining lands, and if care be taken to prevent the sliding into the excavation of overlying soil, the extent and depth of the depression may be taken to be the measure of the amount of asphalt that has flowed from the neighbouring lands into the excavation. The same result may be arrived at by a determination of the amount of asphalt that any digger should be allowed to remove from an excavation of known area and depth, any excess of asphalt won over and above such amount being returned into the possession of his neighbours proportionately to the volume of depression produced in their respective properties. It follows as a direct consequence of the principle, that a digger is at liberty to draw from the stock of asphalt common to all pitch lands, but not unduly to deplete those of his neighbours, that continuous digging, or digging at intervals of time insufficient to enable neighbouring lands in their turn to receive the full benefit of the flow of asphalt from the common stock, is an infraction of the rights of neighbours, and the rate of digging should be prescribed in the regulation. Furthermore, it is suggested that digging licenses should be issued to such diggers as desire them, the effect of these being to confer certain privileges upon the digger, such that he shall not be stopped by injunction from digging according to the regulations so long as he holds the license.

IMPERIAL INSTITUTE BULLETIN,

1903, No. 2.

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THE IMPERIAL INSTITUTE.

The Imperial Institute was founded as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May, 1893. The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of India and the Colonies, and providing for the collection and dissemination of scientific, technical and commercial information relating to them. Until the end of 1902, the Imperial Institute was managed by a Governing Body, of which the Prince of Wales was president, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900, the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the eastern and central portions being assigned to the use of the University of London. In July, 1902, an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of India and the Colonies, as well as of the India and Colonial Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1st, 1903.

In accordance with the above Act, the Imperial Institute is now managed by the Board of Trade in consultation with the Advisory Committee, through their Commercial, Labour, and Statistical Department, of which Sir Alfred Bateman, K.C.M.G., is Comptroller-General.

The Board of Trade have appointed Professor Wyndham Dunstan, F.R.S., hitherto Director of the Scientific and Technical Department, to be Director of the Imperial Institute at South Kensington, with charge of the various branches of work there carried on.

The work hitherto carried on by the Imperial Institute at South Kensington and in the City for the supply of general, commercial, statistical and tariff intelligence is now conducted by the Commercial Intelligence Branch of the Board of Trade, which, subject to the Comptroller-General, is under the direction of Mr. Thomas Worthington. (See statement as to the work of the Commercial Intelligence Branch published in the "Board of Trade Journal.")

The principal entrance of the Imperial Institute is at the west (Queen's Gate) end of Imperial Institute Road. This gives access to the principal floor, containing the general enquiry office, library, reading rooms, colonial conference rooms, and the library and reading room of the Northbrook Society.

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The first floor contains the Director's office, the offices of the British Women's Emigration Association, the Colonial Nursing Association, and the general enquiry office in connection with the Indian and Colonial collections of commercial products.

The second floor is entirely devoted to the laboratories of the Scientific and Technical Department.

The public entrances to the Indian and Colonial collections are at the East (Prince's Gate) end and the West (Queen's Gate) end of the Imperial Institute Road.

The Imperial Institute works in co-operation with the Commercial Intelligence Branch of the Board of Trade at Whitehall, with an enquiry office in the City (49, Eastcheap, E.C.) under the management of this branch, and with the Emigrants Information Office in Westminster.

Indian and Colonial Economic Collections.—The collections of economic products illustrative of the commercial resources of India and the Colonies are arranged on a geographical system in the galleries of the Imperial Institute. Mr. W. G. Freeman, A.R C.S., B.Sc. (Lond.), F.L.S., lately of the Imperial Department of Agriculture for the West Indies, has been appointed Superintendent of these Collections.

Special Curators are appointed by the Governments of India, Ceylon, Canada, and the Cape; whilst the operations of the Indian Section are supervised by a committee appointed by the India Office.

The collections are open free to the public daily, except on Sundays, from 11 a.m. till dusk.

It is intended, in consultation with the Governments concerned, to re-arrange and make extensive additions to many of these collections, and this work has been already commenced.

The following British Colonies and Dependencies are represented by collections of their products:—

BRITISH AFRICA.

Cape Colony.
Natal.
Rhodesia.
British Central Africa.
East and West African Settlements.
Mauritius.
Seychelles.

BRITISH AUSTRALASIA.

New South Wales.
Victoria.
South Australia.
Western Australia.
Queensland.
Tasmania.
New Zealand.
Fiji.

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BRITISH AMERICA.
Dominion of Canada.
Newfoundland.
Bermuda.
Bahamas.
Jamaica.
Barbados.
The Leeward Islands.
The Windward Islands.
Trinidad and Tobago.
British Guiana.
British Honduras.

BRITISH INDIA AND THE EAST.
India.
Ceylon.
Straits Settlements and Federated Malay States.
Hong Kong.
British North Borneo.

OTHER BRITISH POSSESSIONS.
Malta.
Falkland Islands.

Information concerning India and the Colonies, their commercial products, industries, trade, prospects for emigration, &c., may be obtained on application to the Curators for India and Ceylon, Canada and Cape Colony, at their offices in the Sections, at the Central Stand in the Galleries, at the General Enquiry Office, or enquiries may be addressed in writing to the Director of the Imperial Institute, South Kensington, S.W.

The Scientific and Technical Department.—The laboratories of this Department, which occupy the second floor of the Imperial Institute, were established chiefly with the aid of grants from the Royal Commission of the 1851 Exhibition, in order to provide for the investigation of new or little-known products of India and the Colonies and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the trade and industries of India and the Colonies.

The work of the Department is chiefly initiated by Departments of the Governments of India and the Colonies. Arrangements have been also made by the Foreign Office, whereby British Consuls may transmit to the Department for investigation, such natural products of the countries in which they are appointed to reside as are likely to be of use to British manufacturers and merchants.

Materials are first chemically investigated in the laboratories of the Department, which includes a staff of skilled assistants, and are afterwards submitted to technical trials by experts attached to the Department and finally are commercially valued.

Except under special circumstances the Department does not undertake investigations for private individuals.

A few illustrations of the work of the Department may be given here.

(*a*) The examination, in the Department, of Indian plants likely to be suitable as vegetable tanning agents now largely in demand, pointed to the conclusion that several would probably be useful to

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European tanners. One of these (*Cæsalpinia digyna*) was submitted to complete chemical investigation with very promising results. Tanning trials were next made on the large scale by one of the tanning experts attached to this Department, whose results confirmed the conclusion that a valuable tanning agent had been found. On the publication of the report on the subject, which was widely noticed in technical journals, a demand almost at once arose for the material in England, on the Continent, and in America, and the authorities in India are now arranging for the commercial supply.

(*b*) A plant abundant in India (*Podophyllum Emodi*) was found on chemical investigation in the Department to furnish the same constituents as the well-known drug of American origin, *Podophyllum peltatum.* The co-operation of physicians at St. Thomas's Hospital was secured, and preparations of the plant were extensively tried as a drug and found to be as valuable as those made from the American plant. A considerable demand now exists for the plant, which has been officially recognised by the Indian Medical Department, and arrangements are being made in India for a regular commercial supply.

(*c*) The same practical result has followed from the chemical investigation of a plant abundant in the Egyptian Desert (*Hyoscyamus muticus*) for which a commercial demand as a drug has also arisen.

(*d*) The quality of the entire series of Indian coals has been experimentally ascertained. These represented the principal coal-seams of India, and the report has been in large request both in this country and in India. It has now been issued as an official paper by the India Office.

(*e*) The cause of the poisonous effects produced, at certain stages of their growth, on horses and cattle by certain food grains and fodder plants of India and the Colonies has been investigated, and the nature of the poison and the conditions of its occurrence determined.

(*f*) The chemical composition of india-rubber of various kinds derived from the Colonies which do not at present share in this trade, has been determined experimentally, and on the basis of these results commercial valuations have been obtained, and in some instances sales of consignments of the material have been effected.

(*g*) Collections of minerals from British Central Africa, from Somaliland, and from Northern and Southern Nigeria have been chemically examined. In certain cases where it seemed desirable, minerals have been subjected to technical trial on the large scale by manufacturers, and commercial quotations for the products

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obtained. Arrangements have also been made, through this Department, for the working of mineral deposits in the Colonies by English firms.

(*h*) The quality of leather tanned in several of the Colonies has been experimentally investigated, and with the aid of experts its suitability for the English market has been ascertained and suggestions made for its improvement.

(*i*) The chemical composition of certain oil-yielding nuts sent by British Consuls in Brazil and Portuguese South Africa, and from British Honduras, has been investigated and their properties brought under the notice of British manufacturers and brokers. In several cases arrangements are being made for consignments of the products to be sent to this country.

(*j*) Scientific and technical information has been supplied as to the curing of tobacco (Bermuda), the working of mica deposits (Somaliland and Southern Nigeria), the suitability of iron ores for smelting (India), the production of wood-pulp (Natal), the cultivation of Indian hemp, and many similar subjects. It will be seen that the results of the work of the Department are often of as much importance to British manufacturers as to the trade of the Colonies concerned.

The principal Technical Reports and Scientific Papers which have emanated from this Department since it was fully established in 1896 are about to be published.

Library and Reading Rooms.—The library and reading rooms of the Imperial Institute contain a large collection of Indian and Colonial works of reference, and are regularly supplied with a number of the principal official publications of India and the Colonies, and with many of the principal newspapers and periodicals of the United Kingdom, India, and the Colonies. The library also includes a number of Indian and Colonial maps and charts.

The library and reading rooms are on the principal floor of the main building, and are entered through the main entrance at the west (Queen's Gate) end of the building. These rooms can at present be used only by Life Fellows of the Imperial Institute, and by persons introduced by them.

Colonial Conference Rooms.—Three large rooms, specially decorated and furnished, are reserved on the principal floor for use by the representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The rooms in connection with this Hall are in the occupation of the Indian Committee of the Imperial Institute, whilst the Imperial Institute, the India Office

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and the London University have the right of using the Hall for lectures, meetings, &c.

Unofficial Societies occupying rooms in the Imperial Institute:—

(*a*) **The Northbrook Society.**—This Society (which was founded by the Earl of Northbrook) has a Library and Reading Room in the Imperial Institute which is available for the use of its members, who have also the privilege of using the adjoining Library and Reading Rooms of the Imperial Institute. The membership of this Society is open to natives of India and to persons officially connected with, or interested in, the Indian Empire. Communications should be addressed to the Secretary, Northbrook Society, Imperial Institute, S.W.

(*b*) **British Women's Emigration Association.**—The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and the prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants Information Office in Westminster.

(*c*) **Colonial Nursing Association.**—This Association has been assigned an office on the first floor of the Imperial Institute (Room 4). Its principal object is the selection of trained hospital and private nurses for the Crown Colonies and other British Dependencies.

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INDIAN AND COLONIAL COLLECTIONS.

NOTES ON RECENT ADDITIONS.

Central Stand for Publications and Enquiries.—A stand has been opened in the centre of the main gallery to facilitate the answering of enquiries and the distribution of literature. Pamphlets, circulars, handbooks, &c., containing information relating to the commerce, agriculture, mining and other industries of the principal British Colonies, and also to emigration, may be obtained gratuitously. Certain publications are for sale. The publications of the Emigrants Information Office, established by the Colonial Office, may also be obtained. The principal Indian and Colonial newspapers may be seen on application.

An officer of the Institute is in attendance at this stand, which is being placed in telephonic communication with the offices of the Curators and with the General offices in the main building.

India.—A large number of the exhibits in this section have been re-arranged. Preliminary lists of "edible substances," "oil-seeds and oils," "gums and resins," and "dyes and tans," have already been printed, and copies can be obtained gratis on application to the curator of the Indian section, or at the central stand.

An interesting collection of textile fabrics illustrating the use of wax, either for ornamental printing in relief on a coloured ground or as a resist for protecting certain portions of a design from the action of dyes, is being arranged in the Indian section, and will be completed very shortly.

Canada.—A comprehensive collection illustrative of the economic minerals of British Columbia, and also an exhibit of furniture and carriages entirely manufactured in Canada of Canadian woods are being shown in the western end of the North Gallery. A new collection of specimens illustrating the cereal resources of British Columbia has been added to the Canadian section.

Straits Settlements and Federated Malay States.—This section is about to be entirely re-arranged with many additions and improvements. Mr. H. N. Ridley, Director of the Government Botanic Gardens, Singapore, has now in course of preparation, new samples of economic products and other illustrations of the resources of these countries. Mr. Leonard Wray, Curator of the Museum at Perak, is also assisting in this work.

British Central Africa.—New samples of many of the important products of this Protectorate have been received and added to the collection. These products were described in *Imp. Inst. Bulletin*, 1903, i., 9.

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Notes on Recent Additions.

Seychelles.—The Administrator of the Colony has recently forwarded for exhibition in this section samples of copra, cocoanut oil, cloves, pepper, cacao, coffee, vanilla, &c. These samples were placed on view for some months in the City Office of the Imperial Institute, where they came under the notice of brokers and merchants. Valuations of the products were forwarded to the Colony.

British North Borneo.—A collection of the commercial products of British North Borneo, including timbers, coal, rice, sago, sugar, coffee, cacao, pepper, tobacco and cigars, camphor, gutta-percha, dammars, cutch and gambier, is on view in the North Gallery.

Western Australia.—Furniture manufactured from the principal hardwoods of the State, chiefly Jarrah and Karri, illustrating the adaptability of these woods for mouldings and turned work, as well as their susceptibility of taking a high polish and finish, is shown in the North Gallery.

Queensland.—A collection of the more important products of Queensland, especially minerals, and a large number of photographs is being shown in the North Gallery.

Technological Exhibition of the City and Guilds of London Institute.

A collection of students' work in technology and handicraft, arranged by the Technological Examinations Department of the City and Guilds of London Institute, was opened in the North Gallery by the Marquess of Londonderry, K.G., President of the Board of Education, on Thursday, 11th June, and remained open to the public until 20th June.

Exhibition of Designs for the New University at the Cape.

A collection of competitive designs prepared by English and South African architects, for the buildings of the New University at Cape Town, have been on exhibition, at the instance of the Agent-General for the Cape, in the North Gallery.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

I.—REPORTS OF RECENT INVESTIGATIONS.

The following notices have been selected from reports recently made by the Scientific and Technical Department:—

HÆMATITE FROM THE CHOTA UDEPUR STATE, BOMBAY PRESIDENCY.

This sample of iron ore was transmitted to the Imperial Institute by the Acting Chief Secretary to the Government of Bombay, together with a note by the Deputy Superintendent of the Geological Survey of India, stating that deposits of this mineral are abundant in the hills to the north of Moriari, in the Chota Udepur State, and that the mineral might prove to be a valuable iron ore.

The sample weighed 3½ lb., and consisted of bright black laminæ of micaceous iron schist, the ultimate scales being about 1 millimetre in diameter. The specimen contained a piece of shale (not included in the sample analysed), but was otherwise of uniform quality.

The following results were obtained on analysis:—

Ferric oxide	Fe_2O_3	81·02	per cent.	Equivalent to 56·9 per cent. metallic iron.
Ferrous oxide	FeO	0·26	"	
Alumina	Al_2O_3	3·11	"	
Manganous oxide	MnO	Nil.		
Lime	CaO	Nil.		
Magnesia	MgO	0·66	"	
Copper oxide	CuO	Nil.		
Phosphoric oxide	P_2O_5	0·11	"	Equivalent to 0·074 per cent. phosphorus.
Arsenic	As_2O_3	Nil.		
Sulphur	S	Nil.		
Silica	SiO_2	13·68	"	
Water	H_2O	0·74	"	

These analytical results show that the ore is of good quality, free from sulphur and containing little phosphorus. It resembles in composition, and especially in the large amount of silica it contains, the brown hæmatites smelted in Northamptonshire, which furnish usually about 65 per cent. of metallic iron and contain from 10 to 13 per cent. of silica. These ores

Hæmatite from the Chota Udepur State, Bombay Presidency.

are smelted without preliminary treatment. It is to be noted that according to the report of the Deputy Superintendent of the Geological Survey the amount of silica associated with the iron ore may be found to vary considerably in different portions of the deposit.

At Norberg, in Sweden, an ore containing red hæmatite, magnetite and quartz, yielding about 50 per cent. of metallic iron, and containing 20 to 30 per cent. of silica, is concentrated by crushing and washing, and the finely divided "concentrate" so obtained made into briquettes and smelted in the blast furnace. Such a process can be successfully used in the small blast furnaces employed in Sweden, but in America, owing to the ease with which the briquettes break up under the pressure developed in modern blast furnaces, this process is stated to be unsatisfactory. Washing processes of a simple type for the concentration of clay-bearing iron ores are, however, employed in Virginia, Tennessee, and Alabama, so that this preliminary treatment of an iron ore, which may possibly be necessary in the present instance, would not render the cost of working prohibitive.

The next step in this matter should be to determine so far as possible the extent of the deposit and to take samples from different portions, so that these may be submitted to analysis in order to ascertain the average composition of the ore, which cannot be inferred from the analysis of the single sample now reported on.

The practicability of smelting this ore at or near the place of origin will turn chiefly on the possibility of obtaining supplies of coking coal and of good limestone near at hand.

GUTTA (GETAH JELUTONG) FROM SARAWAK.

This specimen of Getah Jelutong and samples of a mineral substance used in its preparation were forwarded from Sarawak, through His Majesty's Consul at Brunei, for examination in the Scientific and Technical Department of the Imperial Institute, and are described in despatches, copies of which were transmitted to the Imperial Institute by the Foreign Office.

From the correspondence accompanying the samples it appears that the mineral substance used in the preparation of the Getah or Gutta is obtained from China, and is known to the Malays as "Menang Sayla," and to the Chinese as "Chio Koh." This substance is not employed in its natural condition, but is baked before use, being reduced thereby to a kind

Gutta (Getah Jelutong) from Sarawak.

of feathery powder, and its addition is said to be essential to the preparation process. The latter is described as follows:—"It (the Getah) is taken from the Jelutong tree, and is obtained by barking the tree and then scraping off the gum as it exudes, and not by tapping, a process which is very destructive to the trees. The Getah must be prepared immediately, and this is done by first sprinkling a pint of kerosene oil in a tub, then a kerosene tin full of water is poured in and the same quantity of the gum, to which is added a teaspoonful of the 'Menang Sayla,' and the whole is then well mixed and afterwards kneaded and rolled into large balls, in which form it is exported." The local value of the product is about 5 dols. per picul, and in Singapore it is from 7 to 8 dols. per picul.

Getah Jelutong is already well known in the European and American markets under the name of Pontianac, but its commercial utilisation is chiefly confined to the United States, which imports large quantities annually. The supply is obtained from Borneo and the Malay Peninsula, and is not restricted to Sarawak as the Consul appears to indicate.

The specimen of the Getah Jelutong was a large cheese-shaped mass, of light brown colour externally, but quite white and of granular structure within; it was almost free from dirt or vegetable debris, but contained a considerable quantity of water, which exuded on pressure, and it had a distinct odour of kerosene; it was soft, could be easily worked in the fingers, and possessed very little tenacity. On exposing a piece to the air for some time, however, the outer portion hardened and became quite friable. When treated with hot water it formed a very soft mass, without becoming sticky, and could readily be moulded, but it did not harden on cooling, merely returning to its original form.

On chemical examination the material was found to contain:—

Moisture	40·8 per cent.
Ash	0·28 „

The dry material was entirely soluble in cold ether, but only partially soluble in alcohol. It did not contain any of the hydrocarbon "gutta," the characteristic constituent of true gutta percha, but the following substances were isolated from it:—

1. A small quantity of a sticky elastic substance, resembling caoutchouc in appearance and properties;
2. A large quantity of a white granular substance;
3. A very small quantity of a distinctly crystalline substance;

the two latter substances being dissolved by hot alcohol.

A comparative examination of a sample of commercial Pontianac gave almost identical results.

Gutta (Getah Jelutong) from Sarawak.

In appearance the Getah Jelutong resembles a poor quality of gutta percha, but its composition, as indicated above, would suggest that it may perhaps be more closely allied to the inferior varieties of rubber.

Getah Jelutong or Pontianac, is usually stated to be obtained from *Dyera costulata*, a large tree which is fairly common throughout the Malayan region, but it is probable that the material as met with in commerce is a mixture of guttas derived from different sources. It has been stated, in fact, that it is the custom of the natives to mix the latex of the Jelutong tree with that derived from different species of *Willughbeia*, which yield inferior rubbers. The value of Pontianac in the London market is about £19 to £20 per ton, but as already stated, the chief demand for the material is in the United States, which in 1901 imported 9,371,087 lb., valued at 248,838 dols. Of this total, 8,708,107 lb. are returned as coming from the British East Indies, probably through Singapore, whilst the remainder, 662,980 lb., was imported from the United Kingdom. After undergoing certain treatment, the Pontianac is chiefly employed in the United States as an ingredient in the mixtures used for the manufacture of rubber goods of low quality, and its utilisation for such purposes appears to be extending.

The sample of Getah Jelutong from Sarawak was almost identical in appearance, composition and properties with commercial samples of Pontianac, being remarkably free from admixture with vegetable or mineral impurities, and it would, no doubt, be suitable for any purpose for which the latter is employed. At present, however, the material is of relatively small commercial value.

Two specimens of the mineral substance used in the preparation of Getah Jelutong were supplied: one of the mineral as imported, the other of the material prepared for use by heating.

The mineral proved to be a specimen of the fibrous variety of gypsum, known as "satin spar" (hydrated calcium sulphate); it was white, translucent, crystalline and massive.

The specimen which had been heated was white and opaque; it was non-crystalline, but retained the fibrous form of the mineral, and readily crumbled to powder in the fingers. It absorbed water, but did not set like plaster of Paris. It contained only 2·48 per cent. of water, so that in course of preparation the gypsum has probably been heated to a high temperature, with the result that the product does not set when mixed with water.

If, as is indicated, the addition of this substance is essential in the preparation of the gutta, it is probably due to the fact that the latex is coagulated by a solution of calcium sulphate, as is known to be the case with several other rubber latices.

RUBBER AND RUBBER-YIELDING PLANTS FROM THE EAST AFRICA PROTECTORATE.

These specimens were forwarded to the Imperial Institute by Sir C. Eliot, Commissioner of the East Africa Protectorate, with a view to the chemical examination and commercial valuation of the rubber, and the botanical identification of the plants from which the rubber was obtained. In the accompanying letter the specimens were described as follows:—

"A sample of the coagulated juice of a vine which grows in "abundance in the Nandi Forest, together with specimens of "the leaves, flowers and fruit; also samples of the rubber, "leaves, flowers and fruit of a vine which grows near Takaungu " . . . . Both plants are abundant in their respective "localities."

The specimens received were, however, more numerous than is indicated above, and comprised:—

1. The leaves, flowers, fruit and coagulated juice of a vine which grows in abundance in the Nandi Forest, Mombasa. Forwarded by Mr. Mayes.
2. Rubber from Nandi. Forwarded by Mr. Hobley.
3. Three rubber vines from Takaungu, labelled Mbungu, Vipo and Impira respectively.
4. A euphorbiaceous rubber plant from Takaungu.
5. Rubber from Takaungu.

The botanical specimens have been identified for this department at Kew by Dr. Otto Stapf, who reports that the vine from the Nandi Forest is *Landolphia Watsoniana*, Voigtherr; the vines from Takaungu, labelled Mbungu and Vipo, prove to be the same species, viz., *Landolphia Petersiana*, Dyer; the vine from Takaungu, labelled Impira (also known as M'pira) is *Landolphia Kirkii*, Dyer; and the euphorbiaceous plant from Takaungu is *Manihot Glaziovii*, Muell-Arg., a native of Brazil. It may be noted here that the "Mbungu" rubber of East and West Africa is usually stated to be obtained from *Landolphia florida*, whereas the plant from Takaungu known by this name is *Landolphia Petersiana*.

Of the three samples of rubber accompanying the botanical specimens, two were forwarded from Nandi, one of these being derived from the vine which has been identified as *Landolphia Watsoniana*, whilst the botanical source of the other is not stated. In the case of the sample of rubber from Takaungu, no indication is given as to the particular plant from which it was obtained.

Rubber and Rubber-yielding Plants from the East Africa Protectorate.

DESCRIPTION OF THE SPECIMENS.

1. Rubber from Nandi, forwarded by Mr. Mayes. Derived from *Landolphia Watsoniana.*

This was a small ball of rubber, about 1½ ins. in diameter, rather sticky and dark brown in colour externally; the freshly-cut surface was pinkish-white in the centre of the ball, but turned brown on exposure to the air, and was not so sticky as the outside surface; it had a sour, mouldy odour, and contained small particles of vegetable matter; the ball was fairly elastic, and fragments of the rubber stretched well without breaking; the rubber partially melted when heated to 120° C.

2. Rubber from Nandi, forwarded by Mr. Hobley.

A small ball of rubber, almost exactly resembling No. 1 in appearance and properties, the only differences being that it contained more moisture and the freshly-cut surface was much whiter.

3. Rubber from Takaungu.

A ball of rubber about 2½ ins. in diameter, brown in colour externally and slightly sticky; the freshly-cut surface showed a mottled appearance, varying from white to light brown in colour, and was not sticky; the ball was slightly porous, and contained small particles of vegetable matter distributed through it; it was very elastic, and fragments of the rubber stretched well without breaking; it went sticky when heated in the water-oven, and melted almost completely at 120° C.

CHEMICAL EXAMINATION.

The results of the chemical examination of the specimens are as follows:—

—	Moisture per cent.	Resin per cent.	Caoutchouc per cent.	Dirt per cent.	Ash (included in dirt) per cent.
I. Rubber from Nandi forwarded by Mr. Mayes	12·9	11·9	67·2	8·0	1·3
II. Rubber from Nandi forwarded by Mr. Hobley	20·8	9·7	61.9	7·6	1·3
III. Rubber from Takaungu	5·7	5·0	84·2	5·1	4·0

These results indicate that, so far as chemical composition is concerned, the rubber from Takaungu is of very good quality, since it contains a low percentage of moisture and resin and 84 per cent. of true caoutchouc, being much superior in these respects to the samples from Nandi, in which the percentage of resin is much higher. The two rubbers from Nandi are, as already pointed out, almost identical in appearance, and also

Rubber and Rubber-yielding Plants from the East Africa Protectorate.

agree very closely in composition, as is seen on comparing the following figures calculated for the dry material:—

	Resin.	Caoutchouc.	Dirt.
I.	13·6	77·1	9·3
II.	12·2	78·2	9·6

It would seem probable, therefore, that the two specimens were derived from the same or very closely allied species of plant.

COMMERCIAL VALUATION.

Samples of the rubbers, together with the results of the chemical examination, were submitted to brokers for commercial valuation. They report that the specimen from Takaungu, which they describe as nice, hard, red rubber, would sell well at about 2*s*. 6*d*. to 2*s*. 7*d*. per lb., *ex* warehouse in London, if not sticky. The samples from Nandi are described as a rather softer rubber, Nyasa character, and dark coated, which, if not heated, would be worth about 2*s*. 3*d*. to 2*s* 4*d*. per lb. The brokers add that all the samples appear to have been externally heated, but suggest that this may possibly have occurred during transit, and that larger consignments might not show this defect. The market is very good at present, and as medium rubbers are scarce, such qualities as represented by the samples would sell readily.

It is clear from the above report that consignments of rubber of similar quality to these samples could be easily disposed of in the London market.

RUBBER FROM MOMBASA, EAST AFRICA PROTECTORATE.

This sample of rubber was forwarded to the Imperial Institute for examination and commercial valuation by Sir C. Eliot, Commissioner of the East Africa Protectorate, and in the accompanying letter it is stated to have been obtained from a creeper which grows in the Shimba Hills near Mombasa. The label upon the specimen furnishes the additional statement that the rubber was obtained from the Wadruma Forest, two hours' journey from Muele Hill, Shimba.

DESCRIPTION OF THE SPECIMEN.

A ball of rubber, about 3 ins. in diameter, light brown in colour externally, and slightly sticky; the freshly cut surface showed a mottled appearance, varying in colour from white to light brown, and was less sticky than the outer surface; the ball was slightly porous, and contained small particles of

Rubber from Mombasa, East Africa Protectorate.

vegetable matter distributed through it; it was very elastic, and fragments of the rubber stretched well without breaking; when heated at 120° C. the rubber partially melted.

In appearance the specimen closely resembles the rubber forwarded from Takaungu, which is dealt with in the preceding report (p. 68).

CHEMICAL EXAMINATION.

The analytical results were as follows:—

Moisture	4·2	per cent.
Resin	4·2	„
Caoutchouc	87·7	„
Dirt	3·9	„

(Ash, included in dirt = 2·5 per cent.)

These figures are very similar to those given by the Takaungu rubber, and prove that the sample is of very good quality.

COMMERCIAL VALUATION.

A specimen of the rubber, together with the results of the chemical examination, was submitted to brokers for commercial valuation, and was classed by them (together with the sample from Takaungu) as nice, hard, red rubber, which would sell well, and be worth 2*s.* 6*d.* to 2*s.* 7*d.* per lb., *ex* warehouse in London, if not sticky.

Consignments of this rubber would no doubt find a ready sale in the London market at the present time.

MURVA FIBRE (SANSEVIERIA ZEYLANICA) FROM THE STRAITS SETTLEMENTS.

An enquiry relating to the value of samples of Murva fibre grown experimentally in the Straits Settlements, was referred to the Imperial Institute by the Commercial Department of the Board of Trade.

The sample which was first forwarded only weighed 2·6 grams, and is stated to have been extracted from a single leaf. It had a white, lustrous appearance and a staple of about 50 cm. (20 ins.). A second sample was afterwards received, which was very similar in character and appearance to the first, except that it had a very slight yellowish tinge.

Owing to the small amount of fibre available, a complete chemical examination could not be carried out, but the following determinations were made by the usual methods. For comparison, the results furnished by the examination of other specimens of the fibre of *Sansevieria zeylanica* by the Scientific

Murva Fibre (Sansevieria zeylanica) from the Straits Settlements.

and Technical Department of the Imperial Institute are also quoted:—

—	Moisture per cent.	Ash per cent.	Cellulose per cent.	Length of Ultimate Fibre.
Straits Settlements	9·9	0·7	75·9	1 — 3 mm.
Grenada	9·5	1·4	72·7	1 — 5 mm.
Assam	9·4	0·7	75·6	1·5 — 3·5 mm.
Colonial and Indian Exhibition (Cross & Bevan) ...	9·7	—	73·1	1·5 — 3 mm.

From these results it appears that the fibre from Selangor is fully equal in quality to specimens obtained from other sources.

The fibre has also been submitted for commercial valuation to two leading firms of fibre brokers, who were informed of the favourable results which it had furnished on chemical examination. One firm reports that the sample is a very strong, clear, hard fibre, of good colour, but rather short and tapering; it is coarser, and not quite so soft and pliable as is usual for the fibre of *Sansevieria zeylanica.* Owing to the want of regular supplies the fibre has not a recognised position on the London market, but consignments of long staple have been sold at very high prices. The value of the present specimen is given at about 35*l.* per ton (Sisal hemp being now 37*l.* per ton), but if long and of similar quality it would be worth 40*l.* per ton and upwards.

The other brokers to whom the fibre was submitted value it at 33*l.* per ton, and 36*l.* per ton if "bright white," at which prices they state it would meet with ready sale.

It would appear from these reports that these samples of fibre of *Sansevieria zeylanica* are of good quality, and that consignments of similar character would probably meet with a ready sale on the London market.

SUMACH FROM BULGARIA.

This sample of sumach was forwarded by H.M. Vice-Consul at Rustchuk, and was transmitted for examination to the Imperial Institute by the Foreign Office.

The Consul states that the plant grows wild on the Danube Plains between Silistria and Rahova, and that the exports, amounting to about 1,390 tons a year, all go to Austria, a country which also exports large quantities of the material from Trieste. The sample represents the uncleaned sumach

Sumach from Bulgaria.

lying in the warehouses, and it would require to be freed from twigs, &c., before being packed. The price asked was 3*l.* 9*s.* 7*d.* per ton, and the cleaning, cartage, &c., from warehouse to wharf is estimated at 2½ per cent. The freight to Galatz is estimated at 2·80 frs. per ton, in addition to which sacks would have to be provided. A through route, *viâ* Galatz, from any of the Danube ports to Liverpool could easily be arranged.

The sample, weighing about 1½ lb., consisted of dry, broken green leaves and small pieces of brown twigs. A chemical examination of the material, including both leaves and twigs, conducted in the Scientific and Technical Department of the Imperial Institute gave the following results:—

——	Percentage on undried Material.	Percentage on Material dried at 105° C.
Moisture	10·0	—
Total ash	4·79	5·32
Ash in aqueous extract	2·32	2·58
Total soluble matter	39·5	43·9
Non-tanning matter	15·9	17·7
Tannin	23·6	26·2

The ash was yellowish-white in colour, and consisted chiefly of calcium carbonate and oxide with a small quantity of ferric oxide.

The percentage of tannin in the sumach of commerce ranges from 15 to 30 per cent., but it is only rarely that more than 20 per cent. is present, so that this sample from Rustchuk, containing 26 per cent. of tannin calculated on the dry material, would appear to be of superior quality.

A sample of the sumach, together with the results of the chemical investigation and the available particulars regarding price, was submitted to brokers for commercial valuation. They report that the sumach is of good quality and that the cost is reasonable, but they consider that the sample is not ground sufficiently finely to compete with the Sicilian article in the English market.

With reference to the commercial possibilities of the material in this country, a definite opinion cannot be expressed until a much larger consignment has been forwarded.

OIL SHALE FROM NATAL.

The shale which is the subject of this report occurs at one of the Natal collieries as "a band between the top and bottom of the seam which is being worked, and again underneath the bottom coal, being altogether about 18 ins. to 2 ft. in thickness." Since it has to be mined in obtaining the coal, the value of the seam would be enhanced if some use could be found for it, and trials upon a small scale have been made in Natal with a view to determine its value for the manufacture of shale oil. The following samples of the products were submitted for examination through the Agent-General for Natal:—

1. A bottle of distillate marked No. 1a, distilled from 22·4 lb. of shale.
2. A sample of the residue (which weighed 19 lb.) remaining in the retort after distillation.

A sample of the original shale was not forwarded with these.

RESIDUE REMAINING IN RETORT AFTER DISTILLATION.

The specimen, which weighed about 2½ lb., was composed of small pieces of a dull, hard, carbonaceous material, closely resembling hard charcoal in appearance. The cleavage is irregular and somewhat conchoidal, while a few pieces show distinct lamination. On ignition it gave the following results:—

Volatile matter and moisture ...	4·30	per cent.
Fixed carbon	66·35	„
Ash	29·35	„
	100·00	

These figures seem to indicate that the original material would be more properly described as an inferior coal than as a shale.

DISTILLATE.

The label upon the bottle was as follows:—

No. 1a No. 2 seam
Original weight of shale ... 22·4 lb.
Weight of residue ... ... 19·0 lb.

In the letter forwarding the samples to the Commissioner of Mines, Natal, the specimen is described as "1 bottle of distillate, marked No. 1a, distilled from 22·4 lb. of shale," so that apparently it represents the total liquid volatile products obtained from that weight of the material. According to the data given above, the shale yielded 15·2 per cent. of volatile matter, and the weight of the distillate represented about one-third of the total.

The distillate, which measured 525 c.c., was composed chiefly

Oil Shale from Natal.

of ammoniacal liquor, with a small quantity of tar, the proportions of these constituents being:—

1.	Ammoniacal liquor	465 c.c.
2.	Tar (free from water)	60 c.c.

The ammoniacal liquor had a pale yellow colour, and smelt strongly of free ammonia and ammonium sulphide; its specific gravity at 18° C. was 1·008.

The tar, which was dark brown in colour and rather viscous, was distilled at the ordinary pressure, when it yielded:—

1. 27 c.c. of crude oil:
   - (*a*) 6 c.c. below 100° C., colourless, burning with luminous flame.
   - (*b*) 10 c.c. from 100° to 230° C., yellow colour.
   - (*c*) 11 c.c. above 230° C., reddish colour, viscous.
2. A residue of pitch; hard and brittle when cold, possessing a high lustre.

The three fractions of crude oil were mixed, treated with sulphuric acid and sodium hydroxide, and re-distilled:—

27 c.c. of crude oil gave	(1) 10 c.c. of oil boiling from 160° to 300° C.; yellowish colour, smell of ordinary paraffin, burned with luminous smoky flame. (2) 5 c.c. of heavy oil. (3) A small residue resembling solid paraffins.

Owing to the small quantity of tar available, the above results can only be regarded as roughly approximating to those which would be obtained by working upon a large scale.

The yield of crude oil, viz., 27 c.c. from 22·4 lb. of shale, is therefore extremely small, and would only amount to 2·7 litres, or 0·6 gallon per ton of shale. Unless the yield of oil can be largely increased by an improved method of treatment, it is improbable that it would be remunerative to work the shale for the oil alone. For comparison it may be stated that the amount of crude oil obtained from the Scotch shales varies from 15 to 40 gallons per ton.

Unfortunately, a sample of the original shale was not forwarded for examination, so that its composition cannot be definitely determined, or the above results checked by an experiment designed to prevent all loss of liquid volatile products. From the data supplied and the yield of ammoniacal liquor and tar, the results given by the original shale on distillation can be approximately calculated as follows:—

Residue	84·82
Ammoniacal liquor	4·60
Tar	0·60
Gas and loss	9·98
	100·00

Oil Shale from Natal.

The yield of volatile matter is therefore very low, only 15·18 per cent., while the proportions of fixed carbon and ash present in the shale are 56·28 and 24·90 per cent. respectively. As already stated, this composition points to the material being an inferior quality of coal rather than a shale, and suggests that attempts might be made to utilise it as a fuel. In Germany and Austria brown coal is extensively employed at present, both for the manufacture of briquettes and for the distillation of oil, different qualities of coal being used for these two purposes. Varieties which yield little oil are converted into briquettes; those richer in oil are distilled when, in addition to the tar from which paraffin and other products are prepared, a residue of commercially valuable coke is obtained, and this is now largely utilised for heating purposes. Regarded from this point of view, the Natal "shale" would belong to the first category, and it might be worth considering whether the material could not be better utilised for fuel either in its natural condition or in the form of briquettes rather than for the distillation of oil. The residue left after distillation would be far less suitable as a fuel than the original material, since it does not form a coke, and, in addition to the loss of volatile matter, the amount of ash would be increased.

In explanation of the fact that the tar yielded only paraffin hydrocarbons, instead of the benzene derivatives which would have been anticipated had the material been a form of coal, it may be pointed out that the temperature attained during the distillation has a considerable influence on the nature of the products. It has been shown that if coal be distilled at a very low red heat paraffin hydrocarbons are chiefly obtained, and this may have been the case in the present instance.

It is impossible to arrive at any definite conclusion concerning the utilisation of the shale from the results of this preliminary investigation, and it is suggested, in the event of it being considered desirable to pursue the matter further, that a consignment of a few hundredweights of the material should be forwarded to this Department for chemical examination and technical trial. This course would enable the exact nature of the material to be ascertained, and would make it possible to indicate the purpose for which it could be most suitably employed.

In July, 1898, a sample of bituminous shale, described as an oil shale, was received from Natal through the Agent-General, and was reported on in October of the same year. This material was found to be an inferior quality of coal, possessing a calorific value of 5,115 calories, and on distillation gave 9 per cent. of oil and tar, together with a quantity of gas equal to 3,588 cubic feet per ton. In general composition the two "shales" would appear to be very similar, but the first sample yielded a much larger percentage of oil and tar.

Bulletin of the Imperial Institute.

THE PREPARATION AND USE OF DRIED POTATOES.

Enquiries have been recently made concerning the preparation and use of dried potatoes in Great Britain. Particulars relating to this subject are not readily accessible, and it has been considered desirable, therefore, to publish the following summary of the information collected by the Imperial Institute with reference to the use of dried potatoes in this and other countries.

Dried vegetables and fruits are employed to a very much greater extent in Germany than in Great Britain, chiefly owing to the fact that supplies of fresh produce cannot be obtained there all the year round as in this country. Desiccated vegetables have become, in fact, a staple article of food in Germany, being regularly supplied to the army and navy, and they are also extensively employed in the mercantile marine and in the German colonies. With special reference to potatoes, it appears that in Germany one-half of the annual crop, which in 1901 amounted to 48,687,000 metric tons, is consumed directly as human food, and large quantities are also utilised for feeding stock. In these circumstances considerable attention has been devoted to the desiccation of potatoes, thereby enabling them to be stored without loss of nutritive properties for a much longer period than the raw produce, and during recent years great improvements have been effected in the desiccating process.

In America a considerable demand has also arisen for supplies of desiccated vegetables in the various mining districts, and consequently their manufacture has been commenced in Canada and the United States. A few years ago large samples of six different varieties, including potatoes, prepared in Ontario, were forwarded to the Imperial Institute, and were transmitted to the War Office for trial.

The forms in which dried potatoes are usually prepared are (1) slices and chips, and (2) granules or groats. The former variety does not appear to be prepared in Great Britain, although a quantity is imported in this form from Germany. The amount thus imported cannot be ascertained, however, as the different vegetables are not separately dealt with in the returns. The preparation of dried potatoes in this country is stated to be restricted to the granulated or groat variety, but these are only consumed to a very limited extent at home, being chiefly employed on board ship, or in countries where fresh potatoes are not readily obtainable, and also to some extent in the army and navy. The quantity prepared here cannot be definitely ascertained, but it is believed that, owing to the present facilities for preserving vegetables in a fresh condition,

The Preparation and Use of Dried Potatoes.

the production, which was never very large, is now steadily diminishing. Factories for the preparation of dried potatoes and other vegetables exist in Essex, in Wigtownshire, and in Ireland.

The price of the granulated potatoes fluctuates with the cost of the raw material. It may be noted that 3 ozs. of the dried potatoes are equivalent to 1 lb. of the fresh vegetable.

When used for human food the dried potatoes are treated with a certain quantity of boiling water, allowed to stand for several minutes in a hot place, and then served as required. In addition to their use as a single vegetable, dried potatoes are also employed as one of the principal ingredients in the mixed vegetables which are largely utilised in a compressed form for military and other expeditions. A largely-used formula for such preparations is as follows:—

Potato	40 per cent.
Carrot	30 "
Cabbage	10 "
Turnip	10 "
Seasoning herbs (onion, leek, celery, parsley, parsnip, &c.)...	10 "

Precise information concerning the methods employed in the preparation of dried vegetables, including potatoes, is not readily obtainable, as manufacturers are very reticent in supplying details regarding the processes they adopt. The following methods of desiccation have been employed for the purpose:—

1. Desiccation by a rapid current of dry air at the ordinary temperature.
2. Drying in hot-air chambers.
3. Drying in heated vacuum evaporators.

Of these, the second and third have received most general application.

It is believed that most of the granulated potatoes prepared in this country are manufactured by Edwards' patented process. In the form of slices or chips dried potatoes are more easily prepared, and the product is stated to keep well. An outline of the process adopted is as follows—

After washing and peeling, the potatoes are cut into thin slices or strips and then placed in boiling water, to which some salt has been added, for five to seven minutes. After this treatment the potatoes are dried in chambers at a temperature of 200-212° F. (90-100° C.), the drying being completed in two or three hours. In working upon a large scale the boiling could be advantageously replaced by steaming, in which case

The Preparation and Use of Dried Potatoes.

the potatoes would probably be first steeped in water with a little salt.

The following description has been given of the process employed in the preparation of the compressed mixed vegetables already alluded to:—

"The vegetables are gathered in the autumn, when they are "in their prime, and carefully sorted, then cleaned, washed, "peeled, sliced, and slightly steamed. The various manipulations were formerly performed by hand, but all are now done "by machinery. The vegetables thus prepared are then dried "in kilns and on lattice-work trays by currents of moderately "hot, dry air, thereby retaining their natural colour, flavour, "and aroma. This stage of the process requires the greatest "care and attention, so as to keep the temperature constantly "at the level as ascertained by experience to be necessary for "each kind of vegetable. The vegetables and herbs are then "carefully mixed in the proportions given above, and then "compressed to one-eighth of their original bulk (when fresh) "by powerful hydraulic pressure into moulds, thus forming "square slabs about three-quarters of an inch thick, grooved so "as to be divided into cakes of five rations each, at the rate "of one ounce per ration, easily separated for convenience of "issue. These slabs are then wrapped in paper and packed by "machinery into square tins, which are hermetically soldered. "Before the lid is soldered down a punch stamps it automatically from the inside with the season of manufacture. When "two years appear on this stamp as '1888-1889' the first is the "year of the crop and the second the year of compression. The "tins are now made of bright 'coke' tin-plate of the best "quality, it having been found by experience that the "vegetables keep much better in this material than in the dull "terne-plate formerly used."

The various operations involved in the desiccation of vegetables are nearly all performed by mechanical means. A large number of ingenious machines have been designed for peeling potatoes, apples, &c., and for cutting them into slices, chips or shreds. These are chiefly of American origin, but are now largely manufactured in Germany also. With reference to drying machines, there are a considerable number upon the market at the present time. For use upon a small scale the "Ryder," an American machine, and the "Geisenheim evaporator," which, in its latest form, is known as the "Gnom (Waas patent) evaporator," appear to have met with general approval. The problem of devising a suitable machine for the desiccation of potatoes has not been entirely solved, however, and quite recently a competition has been opened in Germany, under the auspices of the Agricultural Department, the Alcohol

The Preparation and Use of Dried Potatoes.

Verein and various agricultural societies, in which a series of prizes amounting to 30,000 marks is offered for the best potato-drying apparatus. The one condition imposed is that the machine or system shall be capable of desiccating potatoes so that they can be stored in a form suitable for stock feeding until the next year's crop is ready, and at a cost not exceeding 2½*d.* per centner (110 lb.). Twenty-two competitors have entered the competition, which should result in the production of a thoroughly suitable system for desiccating potatoes. As an indication of the scale upon which some of the different drying processes are worked in Germany, it may be mentioned that the "original Rassmus dryer" is guaranteed to dry 20 tons of potatoes, beets, beet-leaves, or other wet fodder in 24 hours. It is a vacuum evaporator which can be worked either with the exhaust steam from a high-pressure engine, or with steam direct from a boiler, according to circumstances.

ERRATA.

Imperial Institute Bulletin, No. 1.

Page xxvii., line 3 from bottom (in table, column 5), for 2·40 *read* 240.

Page xxvii., line 2 from bottom (in table, column 5), for 2·41 *read* 241.

13607

II.—GENERAL NOTICES.

(*Prepared by the Scientific and Technical Department.*)

SUGAR CANE EXPERIMENTS IN BRITISH GUIANA.

Until about sixteen years ago the sugar cane was propagated only by means of cuttings, and all efforts for its improvement were directed to obtaining canes from various parts of the world, in the hope of introducing a variety that gave good yields under the local conditions of soil, climate, &c., and was resistant to fungoid and insect attacks.

The almost simultaneous discovery, by Messrs. Harrison and Bovell, in Barbados, and Dr. Soltwedel, in Java, of the production of fertile seed by the sugar cane, afforded the possibility of obtaining new varieties by seminal selection. It is convenient to speak of the varieties so obtained as "seedling canes," whilst the varieties previously referred to are designated "old varieties."

Experiments on the sugar cane have been carried on for a long period in the Botanic Gardens of British Guiana. In the earlier years numerous old varieties were grown and tested; later the Government Botanical and Chemical Departments commenced the search for valuable seedlings, and have devoted much time and labour to this work and also to manurial experiments. A special report was issued in 1897 dealing with the period 1892 to 1896, and has now been followed by a *Report on the Agricultural Work in the Botanic Gardens and the Governmental Laboratory for the years* 1896 *to* 1901, by Messrs. G. S. Jenman and J. B. Harrison. It is divided into four chapters dealing with Meteorology, Old Varieties of Canes, Canes raised from Seed and Manurial Experiments respectively.

Climatic Conditions.—The weather during the period varied greatly from year to year; in no year was it consistently favourable for either work in the field or for the continued active growth or maturation of the sugar cane, and in 1898, 1899 and 1900 serious interruptions to the growth and welfare of the cane occurred from this cause, whilst in 1897 the crops were destroyed by a gang of thieves.

The mean annual rainfall for the six years was 84 ins., the maximum being 122 ins. in 1898 and the minimum 53 ins. in 1899. The heavy rain of 1898 proved disastrous to the crops, and the drought of 1899 proved even more injurious, causing a complete failure of the crop.

The rain brought down on the average 121 lbs. of combined chlorine per acre per annum, equivalent to 200 lbs. of common salt. This is considerably higher than the amount brought down in England, which at Cirencester is equivalent to 36 lbs. of common salt per acre per annum.

ugar Cane xperi- ents in ritish uiana.

In British Guiana there are two dry seasons and two wet seasons in the course of the year—September, October and November being dry; December and January, wet; February, March and April, dry; and May to August, wet.

It was observed that the best results with regard to sugar products were obtained, as a rule, with rainfalls of 65 to 70 ins. during the period of growth from 1st December to 1st October, and that the occurrence of heavy and well distributed rainfalls in the months of May and June, or June and July, were of the first importance.

The mean daily sunshine during the years 1896-1901 was 7 hours 3 minutes, the maximum annual mean being 8 hours 10 minutes in 1899 and the minimum 6 hours 51 minutes in 1898.

Old Varieties of Canes.—The experiments with the older varieties of canes were continued, and the results between 1886 and 1901 from 20 varieties are recorded, and show that prior to the commencement of the work with seedlings no varieties were obtained which, under the test of a long series of successive crops, have given more favourable results than the standard West Indian canes, namely the "Bourbon" and the "White Transparent." During the period 1896 to 1901 the soil upon which the varieties were growing had become "Bourbon-sick," that is, satisfactory crops of Bourbon canes could not be obtained from it, even with aid of heavy applications of manure. The "White Transparent" cane, during the whole period 1886 to 1901, gave an average yield of 25·7 tons per acre, yielding on milling 67·9 per cent. of juice. In one gallon of normal juice there was 1·782 lb. of saccharose (pure cane sugar), 0·089 lb. of glucose, and 0·229 lb. of solids not sugar; its "Quotient of Purity" was 84·9, that is, 100 lbs. of the total solids in the juice contained 84·9 lb. of saccharose; its non-sugar quotient was 10·9, that is, 100 lbs. of the total solids in the juice contained 10·9 lbs. of solids other than saccharose and glucose, and its glucose ratio was 4·9, that is, there were 4·9 lbs. of glucose for every 100 lbs. of saccharose in the juice. The indicated yield was 3,425 gallons of juice per acre, equivalent to 2·72 tons of saccharose per acre.

In the period 1897-1901 four of the other varieties gave larger yields of saccharose per acre than the "White Transparent," but on the average of the whole period 1886-1901 none surpassed it.

A small reed-like variety, "Kara-ka-rawa," which the experience of earlier years had indicated as being practically valueless for sugar production, during 1897-1901 gave very heavy crops of canes, due entirely to the very great numbers of canes which sprang from the stools. Its average indicated yield of saccharose during those years was 2·67 tons per acre,

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as against 2·04 tons for the "White Transparent," that is, in the proportion of 132 to 100; whilst on the average from 1886-1901 its yield was only 1·80 tons per acre as against 2·72 tons per acre from the "White Transparent," that is, in the proportion of 66 to 100. This affords a striking instance of the importance of a long series of experiments in arriving at the true value of a cane, and of the risk of relying on the results of even four or five crops. On paper, the results with the "Kara-ka-rawa" in 1897-1901 indicate it to be a cane of exceptionally high value, while practically it is valueless.

Seedling Canes.—Some idea of the amount of work bestowed on the search for satisfactory seedlings may be gathered from the fact that during the six years 1896-1901 313,500 seedlings were obtained, of which about 75,500 survived to be transferred from the seed beds to boxes and baskets, while about 19,000 were selected and planted out in the fields. In addition, the trials of many earlier seedlings were continued.

The weather of 1896 was very favourable for the production of fertile seeds, the rains being well distributed during the flowering season, caused the "arrows" (flowering shoots of the canes) to be well developed. Some "arrows" fell to the ground and a portion of the seed germinated spontaneously. This is probably the first instance recorded of sugar cane seedlings having been observed growing spontaneously in the fields of British Guiana.

In 1897, an exceptionally wet year, many thousand self-sown seedlings of the "Bourbon" cane were obtained. These unfortunately succumbed later to fungoid and insect attacks. During 1901-02 the "Bourbon" "arrowed" again, and some 2,000 seedlings have been obtained. Later reports on these will be awaited with interest.

Very full details are given of the results of the experiments with the seedlings of 1896 and onwards; some of these yielded canes of large size and of high sugar content as well, but it is too early to summarise the results.

The great majority of the seedlings raised prior to 1896 have been gradually rejected, and but few have been retained in cultivation. Of those raised in Barbados in 1889 and brought to British Guiana by Professor Harrison, and of those raised in British Guiana immediately after his arrival, Nos. D 74, D 78, D 95 and D 102 (D indicates that these canes were raised in Demerara) are in cultivation in the Gardens, and the first three are being cultivated on the sugar estates of the colony. Six of the canes raised in 1890 are being cultivated on estates; of those raised in 1892 several are of high promise, but only No. 625 has been grown on any scale on the estates. Seedlings raised in 1891, 1893 and 1894 have been all, or nearly all, re-

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jected; those raised in 1895 and afterwards are still on probation.

The average results obtained during five crops from the varieties of seedlings raised before 1894, and retained in cultivation until 1901 show that 17 of them have given a greater yield of saccharose than "White Transparent," the standard of comparison. "White Transparent" gave 18·4 tons of canes, and 2·04 tons of saccharose per acre; its comparative value is taken as 100. Cane No. 135 gave 33·7 tons of canes and 3·45 tons of saccharose per acre; its comparative value was 169. Six of the others have comparative values exceeding 130. Unfortunately these experimental plot results are not usually confirmed when the canes are cultivated on the scale and under the conditions that obtain on sugar estates. The figures only have value for comparing the relative yields under specific conditions of weather, climate, and cultivation of the varieties, and for indicating their possible relative capabilities. On comparing the above results with those obtained in the period 1892-95, there was a general, more or less well marked, concordance in the relative value of the canes grown on the same soil, but under the varying climatic conditions of the two periods, excepting in the case of No. 135, which in the earlier period had only a comparative value of 97·6 instead of the 169 of the later period.

In 1899 another series of experiments with varieties from seedlings was commenced on fresh land which had not been under cultivation for 20 years or more. The crop of "plant canes" (the crop grown directly from the cuttings planted) was greatly injured by drought in 1900, but the first ratoons (the crop that springs in the second year from the stumps left in the ground after the plant canes have been reaped) in 1901 gave heavy yields, and include several varieties of considerable promise. Four of them gave an indicated yield of over 5½ tons of saccharose per acre.

Considerable interest attaches to the variety B 147; it was obtained in the course of the Barbados seedling experiments (hence the B to denote its origin), and great hopes were entertained of its success. In these British Guiana experiments it has been tried alongside a number of canes derived from the local seedlings, in a set of large plot experiments in a field of exceptional fertility. In 1900, as plant canes, it gave an indicated yield of 5·89 tons of saccharose per acre; and in 1901, as ratoons, it gave 5·64 tons of saccharose per acre. It was amongst the best of the canes tried, though beaten by one or two of the local varieties.

Experiments on the effects of manuring the seedling varieties showed that on the "Bourbon-sick" soil of the manurial experiment field, they gave returns of cane far in excess of the

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Bourbon, both when not manured and when manured with nitrogen in different proportions, and that they respond in a marked degree to nitrogen manuring.

To sum up the result of the work with seedlings, Professor Harrison recommends 22 varieties as worthy of the attention of the planters of the Colony for careful experimental cultivation. He says:—"From the results of all our experiments it is clear that several new varieties of canes give yields far in excess of those of the Bourbon on soils on which the Bourbon has ceased, or is ceasing, to return profitable yields; this result has been very fully corroborated by the experiments conducted on many of the sugar estates of the Colony. It marks an advance of high importance, but the still more important, the crucial question: Will any of the new varieties give yields in excess of those of the Bourbon on soils where that cane flourishes, and, if excess yields are obtained, will they be profitable from the manufacturing point of view? still remains unanswered."

GENERAL DEDUCTIONS WITH REGARD TO SEEDLING CANES.

The extended work with seedling canes has proved the correctness of the following deductions drawn from the results of the earlier years' work with the seedling canes:—

1. It is not possible to form an opinion as to the probable richness of the seedling progeny from the richness of the parent cane. This is applicable not only to the actual seedling but to canes propagated from it by cuttings.

2. In the majority of cases the saccharine richness of the parent variety appears not to be transmitted to either the actual seedlings or to canes propagated from them by cuttings. But in the cases of a few varieties there has been found a tendency for the seedlings to approximate to the sugar contents of the parent kind.

3. Similar conclusions hold good with regard to the percentage of non-sugars ("gums") present in the juice. The glucose-contents, and therefore the glucose-ratio and in part the "quotient of purity" are governed by the relative degree of maturity of the canes examined and analysed.

4. Except in some of the more inferior kinds, among both the old varieties and seedling varieties, the size of the individual cane from which the seed is taken apparently in no way affects the size of its offspring, but there is no doubt, as has been repeatedly shown during the experiments, that the average size of the parent variety, with occasionally conspicuous exceptions, closely governs the average size of its offspring.

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5. Experience has not altogether confirmed the earlier experience with canes obtained from the seeds of seedling canes. Although the majority of the seedlings obtained from the seed of the seedling varieties show deterioration, some have been obtained of considerable promise.

6. The fertility of seeds obtained from seedlings is far greater than it is in those obtained from the majority of kinds of the older canes.

7. While the seedlings of the older varieties with but few exceptions show marked tendency to variation, the seeds obtained from seedling varieties do not possess this property to anything like the same extent, and in many of them the offspring appears to come fairly true to parentage; this is especially the case, among those studied, with No. 95 and No. 74

8. The range of variation among the seedlings is far greater in those obtained from parents which are striped than amongst those derived from self-coloured canes, and this is so with regard to colour, size, and sugar-contents.

Manurial Experiments.—The manurial experiments extended over a period of 11 years, and the results are very fully recorded in the report. From them Prof. Harrison draws the following general conclusions as to the action of manures and of lime upon the crops of sugar canes grown upon very heavy clay-lands and under the climatic and meteorological conditions existing at the Botanic Gardens from June, 1891, to May, 1902:—

1. Nitrogen in the forms of sulphate of ammonia, nitrate of soda, raw guano, and dried blood exerted a favourable influence upon the yield of the sugar-canes, and is without doubt the manurial constituent, the supply of which mainly governs the yield of the plant.

2. When supplied in quantities capable of supplying not more than 40 lbs. of nitrogen per acre there was practically no difference in the effects of sulphate of ammonia and nitrate of soda, but on the whole the former is, in my opinion, the preferable salt to apply. Dried blood and raw guano were inferior to each of these. In the earlier crops of the experiments the best results were obtained by a mixture of one-third nitrate of soda and two-thirds sulphate of ammonia, but during the latter years this mixture has not proved more efficacious than either sulphate of ammonia or nitrate of soda alone.

3. Where applied in quantities supplying more than 40 lbs. of nitrogen per acre, sulphate of ammonia is the best source of

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nitrogen for the sugar cane on the alluvial soils of British Guiana.

4. The sugar-cane made more effectual use of the nitrogen supplied by 200 lbs. per acre of sulphate of ammonia and by 250 lbs. of nitrate of soda than it did of that supplied in heavier dressings. On the whole, dressings of from two to three cwts. of sulphate of ammonia per acre appear to be the most certainly profitable applications of nitrogen, although in favourable seasons the use of still higher proportions may prove successful.

5. The application of superphosphate of lime to plant-canes gave increased yields when added to manurings of nitrogen and potash. But little, if any, advantage was gained by the use of phosphates with ratoon crops, and the opinion is expressed that manurings with superphosphate of lime or with other manures containing phosphates should be restricted to plant canes, the ratoons being manured with nitrogen only.

6. Mineral phosphates to give increased yields must be applied to the soil in such heavy dressings as to render their use decidedly unprofitable.

7. As far as the experiments indicate Thomas-phosphate-powder (slag-phosphate) is the preferable source of phosphates for application to plant canes in lieu of superphosphate of lime.

8. The addition of potash, when applied either as sulphate of potash or as nitrate, has exerted little or no effect. The normal weathering of the constituents of the soil sets free for each crop potash in excess of the quantity necessary for the requirements of the plants. This holds good under the conditions existent in British Guiana, where the greater proportion of the potash taken up by the plants is directly returned to the soil, but where practically the whole of the produce is removed from the land it is probable that partial potash exhaustion may take place in the course of a few crops.

9. The use of lime has resulted in largely increased yields. But whether or not its use will result in profitable increases depends on the price of sugar. Its action appears to have been principally mechanical in improving the texture of the land, and it is a question of much importance whether this effect could not be obtained at a lower cost, and hence more profitably, by the use of light ploughs or other cultivators.

10. The results confirm those of previous experiments, that neither the addition of phosphoric acid, of potash, or of lime to the manures favourably affects the sugar-contents of the juice of the canes. The effects of nitrogenous manurings appear to be to somewhat retard the maturation of the canes,

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and thus the juice of canes manured with them is, as a rule, not so rich in saccharose as is that of canes grown without manure. But this effect is far more than balanced by the larger yields of produce resulting from the application of nitrogenous manures, and to the fact that the increases produced by the nitrogen are principally due to the development of the stalks in length and in bulk, and not to abnormal increases in the amounts of tops and leaves, or the production of new shoots to the stool. In this the effects of nitrogenous manures on the sugar-cane are very similar to those on other plants of the *Graminaceæ.*

CULTIVATION OF COTTON IN THE WEST INDIES.

The possibility of a revival of cotton growing in the West Indies is a matter which, at the present time, is receiving considerable attention. A summary of the available information relating to the subject has been issued recently by the Commissioner of Agriculture for the West Indies (*Cotton Cultivation in the West Indies,* Dulau and Co.), and is intended especially to assist those desirous of undertaking the cultivation of cotton in these islands.

The Imperial Department of Agriculture began some experiments in cotton growing at St. Lucia in 1900 with a view to bringing into cultivation lands that had at one time been used for sugar-cane cultivation but had been abandoned owing either to the poverty of the soil or the arid nature of the climate. Later, owing to the rapid decline in the price of sugar, the idea of taking up the cultivation of cotton as subsidiary to, or in lieu of, that of the sugar-cane, was seriously entertained by the planters at Montserrat, Antigua, St. Kitts, and, more recently, at Barbados. There are, at present, about 600 acres in these islands devoted to the experimental cultivation of cotton.

It is too early yet to estimate the results of the abolition of the sugar bounties; but unless the present cost of production of sugar can be considerably reduced in the islands mentioned, and at Barbados, or the price of 'muscovado' sugar can be maintained uniformly at not less than about 9*l.* to 10*l.* per ton, it is not improbable that cotton growing may be successfully substituted for sugar cultivation in some localities. The result would be that a cotton industry might flourish in these colonies side by side with sugar, cacao, fruit, and other industries.

There is no doubt that the West Indian colonies are well adapted for the cultivation of cotton. They formerly grew

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comparatively large quantities, and, in fact, a hundred years ago, furnished nearly the whole of the cotton supplied from the New World to Europe. In 1801, 25,000 bales were exported; in 1836, 20,000 bales. Cotton was afterwards discarded in favour of sugar and other crops which yielded larger profits. There was a slight revival of cotton planting in the West Indies during the Civil War in America in 1863-1865, but since that time cotton has almost disappeared from the list of exports, the only locality where the cultivation has survived being the small island of Carriacou, a dependency of Grenada.

The conditions prevailing in the West Indies appear favourable to the successful re-establishment of the cotton industry. There are large stretches of cleared land formerly employed for cultivation of the sugar-cane which are well adapted to cotton growing. The soil and climate have, long ago, been proved to be favourable, and the present labour supply, especially in such islands as Barbados, Montserrat, Antigua and St. Kitts, is likely to be equal to the demand, and is available at a lower cost than anywhere in the United States.

The variety of cotton recommended for cultivation is that known as "Sea Island"; it has unusually long fibres, and is, therefore, always valued at a higher price than short-fibred varieties. A point of interest with regard to "Sea Island" cotton is that it is indigenous to the West Indian Islands, and its cultivation there would, therefore, be expected to succeed better than in countries where it has been introduced. It is seldom profitable to grow this variety in localities more than 30 miles from the sea.

The West Indian planters are in favour of at least a partial return to cotton cultivation. It will readily fall into line with the estate routine with which they are already familiar, and it will require almost the same kind of field preparation as the cultivation of the sugar-cane. Irrigation and the use of expensive artificial manures will be unnecessary; for, if the whole of the cotton seed that is produced is converted into meal and the animals are fed with it, it is probable that the resulting manure will be quite sufficient. It is also in favour of a cotton industry that expensive machinery and buildings are not required, and that the crop could be grown and exported within a period of about six to eight months from the time of planting. It is probable that a central ginning factory, costing a few hundred pounds, would be capable of dealing with the crop produced on a comparatively large area.

Bulletin of the Imperial Institute.

COTTON IN DUTCH BORNEO.

A specimen of cotton grown in Borneo was recently submitted for examination to the Director of the Industrial and Commercial College at Enschede, Holland, who reported that it appeared to be equal in fineness and length of fibre to the finer qualities of Egyptian cotton. The length of the fibre was about 1⅛ ins., and the sample was valued at 4*s.* per pound. It was suggested that the plant yielding this cotton should be experimentally cultivated in order to ascertain the yield obtainable from it.

Enquiries made by the Governor-General of Borneo elicited the following information, which was published in the "Indische Mercuur," October, 1901.

The specimen of cotton is the product of a tree occasionally met with on the banks of the Barito River, and known to the natives as "Kapas-rampit." When fully developed it attains a height of 13 ft. and a circumference of from 15 to 16 ins. According to the natives it lives about seven or eight years.

The tree does not occur in the wild state, but is occasionally cultivated as a curiosity by the natives. Formerly, when each native household wove its own cotton, the annual variety of cotton was frequently planted, but the product of this is inferior, the fibre being much shorter than that of "Kapas-rampit," and its cultivation has, therefore, been abandoned.

Although the "Kapas-rampit" grows vigorously in several districts of Borneo, its systematic cultivation has not so far been attempted. No information could be obtained concerning the yield of cotton, but trees were noticed, which were covered with flowers or were quite white with the ripe pods.

The flowers are of a yellowish-white colour; the pods are cylindrical in shape, and trilocular, each division containing about eight seeds.

It is possible that this species of *Gossypium* is not indigenous to Borneo, although it bears a native name, but may have been introduced by the early Dutch trading companies.

The tree grows readily in an argillaceous soil containing a little sand, and is not adversely affected by excess of moisture, which is an important consideration in Borneo, where the climate is humid. Specimens of the leaves and pods sent to Holland were found to somewhat resemble those of "Kapas-borsaar" (*Gossypium vitifolium*), a species cultivated in Java.

Four or five years ago, large plantations of a variety of "Kapas-rampit" were made near Singapore, but were not profitable, since the cotton fibre produced was brittle, and could not be spun. The variety cultivated at Singapore, however, appears to have been different from that found in Borneo.

The experimental cultivation of the plant has recently been commenced at Boentok.

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THE COMMERCIAL USES OF THE INDIAN ACACIAS.

A considerable trade is at present done in India in the export of gums, which find a ready market in Europe and America. The most important gum-yielding trees are the acacias, and consequently considerable interest from this point of view attaches to an article dealing with the Indian acacias, published in a special number of the "Agricultural Ledger," 1902.

Acacia arabica.—This tree is widely distributed throughout India. It is cultivated on a light, sandy loam, and grows well, even in the presence of a fairly large percentage of alkali salts. When young, the tree yields yearly from 4 to 20 ozs. of a soluble light yellow or reddish gum; the product from very old trees is darker coloured and somewhat less soluble in water. The gum, as at present produced, is of no value for confectionery purposes, is nowhere sufficiently abundant to become a famine food, and is generally used in calico printing. The bark of the tree is extensively employed in India as a tanning material, the quality of the bark deteriorates after the tree is from 10 to 12 years old, and owing to the small percentage of tannin contained even in the bark of young trees the manufacture of tannin extract for export would not be profitable.

The pods and leaves are valuable as a cattle fodder, and they are also used medicinally as an astringent. The fact that *Acacia arabica* will grow even in presence of alkali salts renders it particularly valuable in India, where large tracts of alkali lands occur.

The so-called arabic or acacia gums may be divided into three classes:—(*a*) Gum arabic of European commerce, (*b*) East Indian gum arabic, (*c*) Indian gum arabic. The first comprises the product of *Acacia Senegal*, from the French colony of Senegal, a yellow or slightly reddish gum; Kordofan or Turkey gum, exported from districts on the Upper Nile, a colourless gum, completely soluble in water; and Suakim and Mogador gums, inferior products exported from the northern districts of Africa. The second class:—East India gum, is imported into Bombay from Aden and the Red Sea ports, and having been picked and sorted, is re-exported; it is usually a good soluble gum of a white to slightly reddish colour. The third class:—Indian gum arabic, generally known as "Gum Ghatti," is a mixture of acacia gums, of variable quality, the superior properties of the products of *Acacia Senegal, A. catechu* and *A. jacqucmontii* being spoilt by the presence of inferior gums derived from other trees. In some parts of Southern India hand-picking and sorting is now practised, and a better trade is being done.

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The following figures taken from the "Agricultural Ledger," 1902, give the export of Indian gum arabic during the past five years:—

	cwts.	£.
1896-7	58,769	91,979
1897-8	46,525	60,412
1898-9	41,469	60,412
1899-00	46,254	51,398
1900-01	37,553	46,659

In 1900-1901, 2,355 cwts. of East India gum were imported from African and Red Sea ports, and 12,171 cwts. exported, the difference being due probably to adulteration with Indian gum arabic.

Acacia catechu.—The gum produced by this tree is of a pale yellow colour, it is soluble in water, and more nearly resembles true gum arabic than does that of *Acacia arabica.* The timber is only used for the preparation of cutch, although it is a hard and durable wood, takes a fine polish, and seasons well.

The total exports of cutch from India during the last four years, for which statistics are available, were as follows:—

	cwts.	£.
1897-8	97,187	
1898-9	61,669	
1899-00	127,815	164,695
1900-01	101,995	

Acacia concinna.—The pods of this tree are used by the natives as a detergent in the preparation of silk and cotton goods for dyeing. The local trade in these is considerable, and it is suggested they might also be used in Europe.

Acacia Farnesiana yields a soluble gum, but the "Cassie pomade" manufactured from the flowers is the product of most interest.

Acacia jacquemontii.—The gum yielded by this tree is almost colourless and readily soluble in water, with which it forms a highly viscous mucilage suitable for use in pharmacy and confectionery.

Acacia modesta.—This species produces a pale, yellowish, translucent gum (Amritsar gum), which is soluble in water, but is only obtainable in small quantities. The timber of this tree is employed for the manufacture of agricultural implements.

Acacia Senegal, which yields true gum arabic, is only met with in Rajputana and Sind, although, as previously mentioned, it is widely distributed in the Sudan and Senegal.

Many varieties of acacia furnish barks which are used by the natives to facilitate the fermentation of saccharine juices, but the well-ground bark of *Acacia leucophlœa* is considered most suitable for this purpose, and if the quality were more constant even larger quantities would be used.

It may be added that a systematic examination of the chemical and physical properties of Indian gums is now being carried out in the Scientific and Technical Department of the Imperial Institute.

THE KOLA TREE OF THE FRENCH CONGO.

The kola nuts of commerce are the product of the West African tree, *Cola acuminata.* They are employed to some extent in Europe as a drug, and also as a stimulating foodstuff of the same character as tea or coffee. Attention is directed in a recent number of the "Journal d'Agriculture Tropicale" (February, 1903) to a species of kola (*Cola ballayi)* growing in the French Congo, the fruit of which resembles that of *Cola acuminata,* and possesses similar properties. This tree grows well up to an altitude of about 1,400 ft., either on the banks of rivers amid thick undergrowth, or on the open plain, but requires a clay soil containing iron. It attains maturity in ten years and yields in the wild state from 100 to 110 lbs. of nuts per annum, a quantity which is easily doubled by cultivation. The nuts are used by the natives as a sustaining food stuff; they are collected just before ripening and buried in ant-heaps, when the ants remove the yellowish white skin, without attacking the nut, and at the same time cover it with a coating of loam, which prevents access of air to the nut, and so acts as a preservative.

The nuts were for some years exported in considerable quantities from the Congo, but the presence in several cargoes of larvæ of an insect which destroyed the kernels, stopped this trade. The creation of an export trade in these nuts would be of great value to this part of Africa, where much of the soil is quite unsuited for the cultivation of other economic plants.

PRUNING IN TEA CULTIVATION.

In almost all agricultural industries which depend for their success on the continued production of a crop either of fruit or leaf, from a perennial plant, the cutting away of the unnecessary portion of the previous growth is an essential part of the system of culture. This pruning operation is especially

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important in tea culture, but it is one which is often neglected, and over which there is great diversity of opinion as to the best methods of procedure. Much useful information on this subject is contained in a recent number of the "Agricultural Ledger" (1903, No. 1), in which Sir George Watt (Reporter on Economic Products to the Government of India) and Mr. H. H. Mann (Scientific Officer to the Indian Tea Association) give a detailed account of the principles involved in the pruning of the tea plant at different stages of its growth. The following briefly summarises the information contained in this paper:—

The object of pruning is to induce the plant to assume a particular shape, so as to facilitate the cultivation and plucking of the leaf, to increase the average yield, of each plant and to retain or improve the quality of the leaf produced. The operation is carried out by different methods—this is necessary because of the variable conditions of climate, elevation, type of plant and soil—but the principles underlying each system are the same.

The primary object in pruning a young plant grown from seed, is to produce a bush of a particular shape without immediate reference to leaf production. It is also desirable, especially in hot countries, that the bush be made to shade the soil as soon as possible, and finally, so far as is consistent with other requirements, to bring the bush into full bearing at the earliest possible date.

The authors express the opinion that the first pruning of the plant should be as low as possible, and carried out at an early date. Definite rules as to the height cannot be given, as the application of the principle will vary with many factors, especially with the nature of the bush. Thus, whereas the "Assam indigenous" tea plant tends to form a straight, single stem, the "Manipuri" type branches almost from the level of the ground; it is, therefore, necessary to cut the former much lower than the latter, and consequently, in the Assam Valley, the usual practice is to cut the plants at 4 to 6 ins. from the ground, whilst in the Surma Valley, where "Manipuri" plant is almost universal, it is the custom to cut at 12 to 15 ins.

The first pruning, which should not be deferred longer than two years from the date of germination, may be carried out in two ways, either by pruning the seedlings in the nursery when six months old, and planting several months later, or by transplanting the six months' seedlings at the commencement of the rains, and pruning late in the following cold weather. In Darjeeling and other hill districts where the climate is less favourable for tea cultivation it is necessary to leave the plants a considerably longer period before they are sufficiently developed to require pruning.

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It is thought advisable that a whole season should elapse between the operations of first and second pruning, as the wood then becomes more mature and more capable of giving rise to new, vigorous shoots; apart from this, it is essential that the bush should make more wood at this stage of its growth than at any other. Supposing the plant were pruned in the first instance at 4 to 6 ins. from the ground, it should, after the second operation, be 14 to 18 ins. in height.

Throughout the districts of Northern India an annual pruning of the mature bushes is almost universal, but in Ceylon and South India, two years, or even a longer period, is allowed to elapse between two successive operations. The latter practice is considered advantageous under certain conditions, *e.g.*, (1) in the year following heavy pruning, (2) when, owing to the exhaustion of the soil, previous bad pruning or heavy plucking, the bushes become weakly, (3) whenever high quality teas are desired early in the season. The decrease in the size of the leaves of a bush which has been left unpruned rapidly puts a limit to the possible length of time it can be left, and hence only a part of a garden can be dealt with in this manner each season.

It is generally recognised that the annual pruning should be undertaken late in the season, and not immediately after the sap has ceased to ascend, as advised by some writers. There is a tendency for pruning to become earlier rather than later, and this is to be discouraged for several reasons, the chief being that early pruning induces early growth, which is valueless should a drought follow, and further, red spider and other blights are invariably more severe on the earliest-pruned bushes.

The position and the angle of section when pruning are important considerations. If the knife is inserted below the base of the bud, and a long slanting section made, the bud will be starved and thus produce a sickly shoot. If the section be made at a point, say, from ½ to 2 ins. above the bud, the protruding portion will be starved, and die accordingly. This is the condition known to the gardener as a "snag," the effect of which is to retard the circulation of the sap.

The annual pruning should, for every individual twig, be conducted so that the cut leaves practically no wood above the bud from which the new shoot is to arise, and makes an angle of about 45 degrees with the stem of the bush.

When pruning lightly, the wood formed since the previous year should be cut well back, so that sufficient is left to contain a bud either actual or dormant. This is important, for the object of the pruning is to produce maximum vigour in the bearing shoots, and it is known that the vigour increases with the shortening of the length of wood from which the shoots arise.

Pruning in Tea Cultivation. It is the general practice when pruning a tea-garden lightly, to cut the tops of the bushes flat, or, as is technically known, to "table prune." The authors of the article are opposed to this method on the ground that the shoots have to be cut unequally, and that such treatment causes the maximum luxuriance of the bush to be at the centre, and the growth of useless shoots on the outside edges. It would seem that as the object in view is to produce an equally vigorous area all over the bush, the new wood on each shoot should be cut to approximately the same length, for by this means it is thought that a higher yield of equal quality tea would result.

The most vigorous shoots as a rule are those which approach most nearly to the vertical position; it is, therefore, proposed that the sides of the bushes should be cut so as to induce vertical growth.

At the time of each annual pruning it is necessary to consider to what extent the bushes require thinning out. The vigour of the shoots depends on the number contained in the bush, and if this number is large, a fair proportion will probably be small and twiggy, and yield nothing but *banjhi* leaves, which are useless for tea, and diminish the strength of the stronger yielding shoots. It is the opinion of some planters that these leaves serve a useful purpose, and hence their growth should not be prevented, but it is desirable to thin out the bushes of the non-bearing *banjhi* shoots, and leave only as many branches as the plant is capable of nourishing properly.

When a bush has undergone several seasons of light pruning, with the necessary continual plucking, it becomes less capable of providing vigorous shoots, and finally the treatment known as "heavy pruning" becomes necessary. This operation should never be undertaken without adequate cause, and the longer it can be delayed the better. It is, therefore, essential that the soil be kept well nourished, for by this means the bush will continue to flourish for a longer period before it becomes necessary to "heavy prune."

A series of experiments is now in progress to decide at what point a bush should be cut when heavy pruned. This is a question about which planters are at variance, and must, therefore, be a matter of doubt until the completion of the experiments referred to. Nevertheless, attention is drawn to a few principles which show what is required.

(1) It should not be necessary to cut so low that the shape and framework of the bush is destroyed. (2) As few knots as possible must be left below the cutting. (3) Grey, lichenous growths on the bush are a sign that the wood on which they have grown has ceased to grow vigorously, although this hardly applies to the Darjeeling and other hill districts, where

Pruning in Tea Cultivation.

lichen and moss growths are commoner than elsewhere. (4) It is very necessary that the land be well manured either before or at the time of "heavy pruning," which must be done as early in the season as possible.

In discussing the treatment of the bushes after the operation of "heavy pruning," it is argued that nursing the bushes, even to the extent of leaving them quite unpruned for a season, is the most economical method, even if it means the temporary loss of a part of the crop.

"Collar pruning" consists in cutting down a bush at that portion known as the collar, which is the point of union between the root and stem. This treatment should be of exceptional occurrence, and only undertaken when the wood is incapable of providing new growth of any vigour, a condition noticeable in old gardens, but often the result of previous bad pruning. The operation is carried out early in the season, the cut being made in a slanting direction, and preferably beneath rather than above the surface of the ground. The stump of the bush should be left uncovered and the cut surface painted with vegetable tar, as this affords protection from the attacks of white ants.

For the successful rearing of a "collar-pruned" bush, the manuring of the land is an essential condition, and the subsequent treatment of the bush should be such that no appreciable yield of leaf can be expected for at least 18 months, as the necessity of providing a framework for the bush is of primary importance, just as is the case with a young plant.

In conclusion, the authors emphasise the fact that pruning is a scientific operation of the utmost importance, and one exercising a paramount influence on the future and permanence of the tea garden; they likewise express the opinion that planters will find it more advantageous and economical to devote great care and attention to this operation, as there is good reason to believe that the results will fully justify any increased expenditure involved.

CULTIVATION OF THE GAMBIER PLANT IN SUMATRA.

The tanning material known as gambier, or white catechu, is a product obtained by extracting the leaves and twigs of East Indian plant, *Uncaria gambier*, and concentrating the extract so produced until it solidifies. Until quite recently this material was almost entirely produced in the Straits Settlements, but within the last few years its manufacture has been commenced in Sumatra and Java, and according to

Cultivation of the Gambier Plant in Sumatra.

a recent number of the "Journal d'Agriculture Tropicale" (March, 1903), the care bestowed in Sumatra on the cultivation of the plant and in the manufacture of the extract has led to the production of a high quality gambier, which is gradually displacing the products of other districts. The young plants, when from 7 to 8 ins. in height, are planted out, so that merely the tip of the stem shows above ground; this treatment usually results in the production of a large number of lateral roots, so that the plant is less liable to be torn out of the ground by strong winds, and is less susceptible to the attacks of fungoid growths. The twigs and leaves for the preparation of the extract are obtained by careful pruning of the plants with shears, this method being less harmful than lopping the branches with knives as was formerly practised. The twigs are first cut up in a chaff-cutter, and then extracted by boiling with water, the extract being then concentrated until it almost solidifies; at this point it is allowed to stand for an hour to cool, then cut into the usual cubical pieces, which are finally dried by artificial heat. In this way, it is stated, a product lighter in colour than ordinary gambier is obtained.

THE PETROLEUM INDUSTRY OF CANADA.

The Canadian petroleum industry, though small in comparison with that of the United States or of Russia, contributes materially to the wealth and prosperity of the Province of Ontario, in which the principal Canadian oil wells are situated. The total output of petroleum from Canada in 1900 amounted to 24,000,000 gallons, equivalent to nearly ·36 per cent. of the world's production, and practically the whole of this was raised in Ontario. Indications of the existence of petroleum have been observed in the provinces of Quebec, Nova Scotia and the North West Territories, and recently wells have been sunk in New Brunswick, but at present petroleum is produced in commercial quantity only in Ontario, and in this province its occurrence is confined to the counties of Lambton and Kent. The former field is situated on the great Cincinnati anticlinal, a ridge stretching from the southern part of the United States to Ontario; the two principal fields are situated on anticlinals transverse to this, at Petrolea and Oil Springs. In these districts the petroleum deposits occur in the corniferous limestone at depths of from 460 to 480 ft., but it is uncertain whether they were formed *in situ* or were produced at a lower level—in the Trenton rocks, at depths of 4,000 ft.—and have been forced through sub-

The Petroleum Industry of Canada.

terranean rock fissures into their present position. If the latter view is correct it is probable that no further deposits will be found at lower levels, whilst if the former view represents the true state of affairs it is possible that further workable wells will be found at depths of about 4,000 ft. A number of wells have, however, already been sunk to the lower depth, but, so far, without result. On the other hand, petroleum has been found in this deeper formation at Ohio in the United States. A general *resumé* of the present state of the Canadian petroleum industry was recently communicated to the Toronto section of the Society of Chemical Industry ("Journal of the Society of Chemical Industry," April 15th, 1903, 393), by Mr. W. J. K. Vanston, and as considerable interest is now being taken in this country in the utilisation of petroleum as fuel, and, therefore, in Colonial oil deposits, the following summary of the article referred to has been compiled.

Except in the very early days of the industry the Canadian wells have never been of a highly productive type, so that the experience gained in the United States and Russia, where oil exudes from the borings under natural pressure, was not available in Canada. The result has been that a distinctly local system has been slowly evolved, distinguished by its simplicity and economical working, so that at the present time a well producing only from eight to ten gallons of oil per day, can be profitably worked. The borings through the surface soil are made by means of a "mud-bit" about 8 ins. in diameter; when the rock is reached a wooden conductor is inserted and the boring continued with a steam drill to a depth of 465 to 480 ft. An iron tube is then pushed through the soapstone to a depth of 300 ft. to keep out water, and finally the well is "shot" with a charge of nitro-glycerine, and is then ready for pumping operations. The pumping is managed from a central station, the various wells of a group being connected to this and to each other by a "jerker line" consisting of wooden rods suspended horizontally from vertical posts by light iron rods. The whole of the wooden rods are attached to a central wheel, which moves backward and forward at each stroke sufficiently far to raise and lower the rods of the pumps. By such means, as many as 233 wells scattered over an area of 400 acres have been operated at once from a central station by four engines working in two pairs.

The oil is usually stored in underground tanks walled with planks, but having floors of the clay soil of the district, which is impermeable to petroleum. For the transportation of oil from the wells to the refineries, which are situated at Sarnia on the St. Clair River, and at Petrolea, pipe-lines have been laid.

The production of petroleum in Canada has shown during

The Petroleum Industry of Canada.

the last few years a considerable decline; thus, in 1899 the output from Ontario was 808,570 barrels of 35 gallons each, in 1900 this had fallen to 710,498 barrels, and in 1901 there was a further decline to 588,528 barrels, and this, it is stated, still continues. A similar condition is shown by the inspection returns issued by the Geological Survey of Canada for 1900, which show that the percentage of oil of home production used in Canada has steadily declined from 93·1 per cent. in 1881 to 61·3 per cent. in 1900. This decline is due essentially to the failure of supply in the fields, and the great want of the Canadian industry at the present time is the discovery of oil deposits in new districts. Experiments have already been made under Government auspices in the North West Territories, but, so far, only natural gas has been found. From this point of view it is of interest to note that a petroleum well has been sunk in New Brunswick, and a deposit struck which appears to run quite across the province from south-east to north-west. Samples of the oil from this field were examined in 1902 in the Laboratories of the Scientific and Technical Department of the Imperial Institute and found to be of marketable quality. It may be added that a report on the petroleum resources of Great Britain, the Colonies and India is now being prepared in the Scientific and Technical Department of the Imperial Institute.

THE CANADIAN NICKEL INDUSTRY.

During recent years much work has been done in connection with the strengthening of steel by the addition to it of other metals. Manganese, chromium and nickel have been found to exert a remarkable influence, even when present in comparatively small quantities, and the last named metal is now extensively used in the manufacture of nickel steel. In view of the ever-increasing demand for greater strength, without a corresponding increase in weight, especially in marine work, the application of nickel is likely to be greatly extended.

The general condition of the nickel industry, especially as carried on in Canada, is dealt with in a recent number of "Engineering" (Vol. LXXV., p. 48), from which the following information is compiled.

At Snider, in Ontario, an immense deposit of nickelliferous pyrrhotite and copper pyrites, believed to cover an area of ten acres, was opened last year. Mining is carried on at present in an open cast with vertical sides showing nothing but a clean ore consisting of pyrrhotite with some chalcopyrite, the average assay value being estimated at less than 2 per cent. of copper and over 7 per cent. of nickel. In the large, open

The Canadian Nickel Industry.

mines at Copper Cliff, the grade of ore obtained is still satisfactory, and another large deposit of equally high grade has been struck. This ore consists of a mixture of nickelliferous pyrrhotite, pentlandite, chalcopyrite and diorite. The second of these contains about 35 per cent each of nickel and sulphur and 30 per cent. of iron. Nickel is also contained in the pyrrhotite as an impurity, sometimes replacing iron to the extent of 3 per cent. The ore is free from arsenic and antimony, but there are present traces of gold, platinum and palladium.

The smelting process adopted consists of roasting the ore for about 12 weeks, the sulphur dioxide produced in this operation being allowed to escape, as no satisfactory method of utilising it has yet been devised. After this preliminary treatment, the roasted ore is smelted, with an admixture of about one-sixth of its weight of coke, to produce low grade mattes. These are then subjected to a repetition of this treatment, whereby the content of metal is raised from 30 to about 70 per cent. For the final separation of the nickel and copper, the material undergoes a series of smeltings with various alkalis, followed by an electrolytic treatment.

The high grade "mattes" thus obtained are in some cases worked up in Canada by electrolytic processes, and in others are exported as such to England and smelted here for their contained metal by the Mond process, which depends upon the conversion of the nickel into a volatile compound by the action of carbon monoxide and the subsequent decomposition of this by ignition.

The following table ("Report of the Bureau of Mines of Ontario for 1902") gives the principal features of the nickel-copper industry for the last three years, and shows that substantial progress has been made during that period:—

	Tons.	Tons.	Tons.
Ore raised	203,118	216,695	326,945
Ore smelted	171,230	211,960	270,380
Low grade matte produced	19,109	23,336	29,558
High grade matte produced	106	112	15,546
Nickel contents	2,872	3,540	4,441
Copper contents	2,834	3,364	4,197
	Dols.	Dols.	Dols.
Value of nickel	526,104	756,626	1,859,970
Value of copper	176,236	319,681	589,080

During the ten years 1892-1901, the total weight of nickel-copper and copper ores raised in Ontario was 1,306,722 tons. Of this quantity, 1,245,422 tons have been smelted into matte containing 26,606 tons of metallic nickel and 28,070 tons of copper, the value of the former being about 4¼ million sterling, and of the latter nearly 1½ million sterling.

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THE SEDIMENTARY DEPOSITS OF SOUTHERN RHODESIA.

The discovery in Rhodesia of rich mineral lodes and deposits has led to a rapid development of that country, which only a few years ago was little known, with the result that vigorous prospecting and the opening-up of mines has afforded much useful information regarding the geological formation of this part of Central Africa, a summary of which was given recently by Mr. A. J. C. Molyneux before the Geological Society of London.

The basement rocks of Southern Rhodesia consist of gneiss schists and granite, which contain the auriferous veins worked in ancient times and now being developed on an extensive scale. Much of the area is covered by sedimetary beds containing a coal-bearing formation. The district from Bulawayo, 170 miles north to the Zambesi Road, is occupied by thick beds of fine sandstones, which form an escarpment at their northern extremity, and in the north-east are elevated to form the Mafungibusi Hills. Below the sandstones occur the grits and shales of the coal-measures as is shown in the following section:—

	Thickness in feet.
Taba' Sinduna Series, Sandstones and Volcanic Rocks ...	200
Forest Sandstones	1,000
Escarpment Grits	400
Upper Matabola Beds (fossiliferous), Coal Measures ...	200
Busse Series (fossiliferous), Sandstones and Grits... ...	300
Lower Matabola Beds, Coal Measures	200
Sijarira Series, Quartzites and current bedded sandstones..	2,000

Fossils have been found in the coal measures, comprising mollusca, plant and fish remains, which indicate the age of these beds to be permo-carboniferous. The coal measures yield an excellent coal, and the areas in which seams outcrop, or have been worked, are described under the names of Mafungibusi, Sesami, Sengwe, Lubu, Sebungu and Wankie Coalfields in the north, and the Tuli and Sabi Coalfields in the south. Volcanic rocks are well displayed in a large area extending from Maclantsie to the Bubi River, a distance of 200 miles, and the extinct craters are visible at Fort Tuli, which gives the name of Tuli Lavas to this district. Numerous hot springs occur along the Zambesi Valley.

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THE IMPERIAL INSTITUTE.

The Imperial Institute was founded as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May, 1893. The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of India and the Colonies, and providing for the collection and dissemination of scientific, technical and commercial information relating to them. Until the end of 1902, the Imperial Institute was managed by a Governing Body, of which the Prince of Wales was president, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900, the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the eastern and central portions being assigned to the use of the University of London. In July, 1902, an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of India and the Colonies, as well as of the India and Colonial Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1st, 1903.

In accordance with the above Act, the Imperial Institute is now managed by the Board of Trade in consultation with the Advisory Committee, through their Commercial, Labour, and Statistical Department, of which Sir Alfred Bateman, K.C.M.G., is Comptroller-General.

The Board of Trade have appointed Professor Wyndham Dunstan, F.R.S., hitherto Director of the Scientific and Technical Department, to be Director of the Imperial Institute at South Kensington, with charge of the various branches of work there carried on.

The work hitherto carried on by the Imperial Institute at South Kensington and in the City for the supply of general, commercial, statistical and tariff intelligence is now conducted by the Commercial Intelligence Branch of the Board of Trade, which, subject to the Comptroller-General, is under the direction of Mr. Thomas Worthington. (See statement as to the work of the Commercial Intelligence Branch published in the "Board of Trade Journal.")

The principal entrance of the Imperial Institute is at the west (Queen's Gate) end of Imperial Institute Road. This gives access to the principal floor, containing the general enquiry office, library, reading rooms, colonial conference rooms, and the library and reading room of the Northbrook Society.

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The first floor contains the General offices, the Reference Sample Room of the Scientific and Technical Department, the offices of the British Women's Emigration Association, and the Colonial Nursing Association.

The second floor is entirely devoted to the laboratories of the Scientific and Technical Department.

The public entrances to the Indian and Colonial collections are at the East (Prince's Gate) end and the West (Queen's Gate) end of the Imperial Institute Road.

The Imperial Institute works in co-operation with the Commercial Intelligence Branch of the Board of Trade at Whitehall, with an enquiry office in the City (49, Eastcheap, E.C.) under the management of this branch, and with the Emigrants Information Office in Westminster.

Indian and Colonial Economic Collections.—The Collections of economic products illustrative of the commercial resources of India and the Colonies are arranged on a geographical system in the galleries of the Institute. Mr. W. G. Freeman, A.R.C.S., B.Sc. (Lond.), F.L.S., lately of the Imperial Department of Agriculture for the West Indies, has been appointed Superintendent of the Colonial Collections.

Special Curators are appointed by the Governments of India, Ceylon, Canada, and the Cape; whilst the operations of the Indian Section are supervised by a committee appointed by the India Office.

The Collections are open free to the public daily, except on Sundays, from 11 a.m. till dusk.

It is intended, in consultation with the Governments concerned, to re-arrange and make extensive additions to many of these collections, and this work is in progress.

The following British Colonies and Dependencies are represented by collections of their products:—

British Africa.	British Australasia.
Cape Colony.	New South Wales.
Natal.	Victoria.
Rhodesia.	South Australia.
British Central Africa.	Western Australia.
East and West African Settlements.	Queensland.
Mauritius.	Tasmania.
Seychelles.	New Zealand.
	Fiji.

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BRITISH AMERICA.

Dominion of Canada.
Newfoundland.
Bermuda.
Bahamas.
Jamaica.
Barbados.
The Leeward Islands.
The Windward Islands.
Trinidad and Tobago.
British Guiana.
British Honduras.

BRITISH INDIA AND THE EAST.

India.
Ceylon.
Straits Settlements and Federated Malay States.
Hong Kong.
British North Borneo.

OTHER BRITISH POSSESSIONS.

Malta.
Falkland Islands.

Information concerning India and the Colonies, their commercial products, industries, trade, prospects for emigration, &c., may be obtained on application to the Curators for India and Ceylon, Canada and Cape Colony, at their offices in the Sections, at the Central Stand in the Galleries, at the General Enquiry Office, or enquiries may be addressed in writing to the Director of the Imperial Institute, South Kensington, S.W.

The Scientific and Technical Department.—The laboratories of this Department, which occupy the second floor of the Imperial Institute, were established chiefly with the aid of grants from the Royal Commission of the 1851 Exhibition, in order to provide for the investigation of new or little-known products of India and the Colonies and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the trade and industries of India and the Colonies.

The work of the Department is chiefly initiated by Departments of the Governments of India and the Colonies. Arrangements have been also made by the Foreign Office, whereby British Consuls may transmit to the Department for investigation, such natural products of the countries in which they are appointed to reside as are likely to be of use to British manufacturers and merchants.

Materials are first chemically investigated in the laboratories of the Department, which has a staff of skilled assistants, and are afterwards submitted to technical trials by experts attached to the Department and finally are commercially valued.

Except under special circumstances the Department does not undertake investigations for private individuals.

A few illustrations of the work of the Department may be given here.

(*a*) The examination, in the Department, of Indian plants likely to be suitable as vegetable tanning agents, pointed to the conclusion that several would probably be useful to European

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tanners. One of these (*Cæsalpinia digyna*) was submitted to complete chemical investigation with very promising results. Tanning trials were next made on the large scale by one of the tanning experts attached to this Department, whose results confirmed the conclusion that a valuable tanning agent had been found. On the publication of the report on the subject, which was widely noticed in technical journals, a demand almost at once arose for the material in England, on the Continent, and in America, and the authorities in India are now arranging for the commercial supply.

(*b*) A plant abundant in India (*Podophyllum Emodi*) was found on chemical investigation in the Department to furnish the same constituents as the well-known drug of American origin, *Podophyllum peltatum.* The co-operation of physicians at St. Thomas's Hospital was secured, and preparations of the plant were extensively tried as a drug and found to be as valuable as those made from the American plant. A considerable demand now exists for the plant, which has been officially recognised by the Indian Medical Department, and arrangements are being made in India for a regular commercial supply.

(*c*) The same practical result has followed from the chemical investigation of a plant abundant in the Egyptian Desert (*Hyoscyamus muticus*) for which a commercial demand as a drug has also arisen.

(*d*) The quality of the entire series of Indian coals has been experimentally ascertained. These represented the principal coal-seams of India, and the report has been in large request both in this country and in India. It has now been issued as an official paper by the India Office.

(*e*) The cause of the poisonous effects produced, at certain stages of their growth, on horses and cattle by certain food grains and fodder plants of India and the Colonies has been investigated, and the nature of the poison and the conditions of its occurrence determined.

(*f*) The chemical composition of india-rubber of various kinds derived from the Colonies which do not at present share in this trade, has been determined experimentally, and on the basis of these results commercial valuations have been obtained, and in some instances sales of consignments of the material have been effected.

(*g*) Collections of minerals from British Central Africa, from Somaliland, and from Northern and Southern Nigeria have been chemically examined. In certain cases where it seemed desirable, minerals have been subjected to technical trial on the large scale by manufacturers, and commercial quotations for the products

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obtained. Arrangements have also been made, through this Department, for the working of mineral deposits in the Colonies by English firms.

(*h*) The quality of leather tanned in several of the Colonies has been experimentally investigated, and with the aid of experts its suitability for the English market has been ascertained and suggestions made for its improvement.

(*i*) The chemical composition of certain oil-yielding nuts sent by British Consuls in Brazil and Portuguese South Africa, and from British Honduras and the Straits Settlements, has been investigated and their properties brought under the notice of British manufacturers and brokers. In several cases arrangements are being made for consignments of the products to be sent to this country.

(*j*) Scientific and technical information has been supplied as to the curing of tobacco (Bermuda, British Central Africa, Rhodesia, and Assam), the working of mica deposits (Somaliland and Southern Nigeria), the suitability of iron ores for smelting (India), the production of wood-pulp (Natal), the cultivation of Indian hemp, and many similar subjects. It will be seen that the results of the work of the Department are often of as much importance to British manufacturers as to the trade of the Colonies concerned. A large room on the first floor, which formerly contained the library, is now occupied by a reference collection of samples of economic products, derived chiefly from India and the Colonies, which have been investigated and reported on by the Scientific and Technical Department, and as to which full information is available.

The principal Technical Reports and Scientific Papers which have emanated from this Department since it was fully established in 1896 have now been published in a single volume, which may be purchased at the Central Stand (price 15*s*.).

Library and Reading Rooms.—The library and reading rooms of the Imperial Institute have been entirely re-arranged during the present year. They contain a large collection of Indian and Colonial works of reference, and are regularly supplied with a number of the principal official publications of India and the Colonies, and with many of the principal newspapers and periodicals of the United Kingdom, India, and the Colonies. The library also includes a number of Indian and Colonial maps and charts.

The library and reading rooms are on the principal floor, and are entered through the main entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of persons introduced by them. Adjoining is the library and reading room of the Northbrook Society.

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Colonial Conference Rooms.—Three large rooms, specially decorated and furnished, are reserved on the principal floor for use by the representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The rooms in connection with this Hall are in the occupation of the Indian Committee of the Imperial Institute, whilst the Imperial Institute, the India Office and the London University have the right of using the Hall for lectures, meetings, &c.

Unofficial Societies occupying rooms in the Imperial Institute:—

(*a*) **The Northbrook Society.**—This Society, founded by the Earl of Northbrook, has a Library and Reading Room, which has been transferred to the principal floor of the Imperial Institute, and is available for the use of its members, who have also the privilege of using the adjoining Library and Reading Rooms of the Imperial Institute. The membership of this Society is open to natives of India and to persons officially connected with, or interested in, the Indian Empire. Communications should be addressed to the Secretary, Northbrook Society, Imperial Institute, S.W.

(*b*) **British Women's Emigration Association.**—The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and the prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants Information Office in Westminster.

(*c*) **Colonial Nursing Association.**—This Association has been assigned an office on the first floor of the Imperial Institute (Room 5). Its principal object is the selection of trained hospital and private nurses for the Crown Colonies and other British Dependencies.

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INDIAN AND COLONIAL COLLECTIONS.

NOTES ON RECENT ADDITIONS.

Central Stand for Publications and Enquiries.—A stand has been opened in the centre of the main gallery to facilitate the answering of enquiries and the distribution of literature. Pamphlets, circulars, handbooks, &c., containing information relating to the commerce, agriculture, mining and other industries of the principal British Colonies, and also to emigration, may be obtained gratuitously. Certain publications are for sale. (See lists on cover.) The publications of the Emigrants Information Office, established by the Colonial Office, may also be obtained. The principal Indian and Colonial newspapers may be seen on application.

An officer of the Institute is in attendance at this stand, which is in telephonic communication with the offices of the Curators and with the General offices in the main building.

India.—A large number of the exhibits in this section have been re-arranged. Preliminary lists of "edible substances," "oil-seeds and oils," "gums and resins," and "dyes and tans," have already been printed, and copies can be obtained gratis on application to the Curator of the Indian section, or at the Central stand.

An interesting collection of textile fabrics illustrating the use of wax, either for ornamental printing in relief on a coloured ground or as a resist for protecting certain portions of a design from the action of dyes, has been arranged in the Indian section. An extensive collection of samples of textile fabrics, including tweeds, serges, drills. twills, sheeting, towelling, &c., contributed by Bombay and Madras manufacturers has now been arranged in the East Gallery.

Canada.—A comprehensive collection illustrative of the economic minerals of British Columbia, and also an exhibit of furniture and carriages entirely manufactured in Canada of Canadian woods are being shown in the western end of the North Gallery. A new collection of specimens illustrating the cereal resources of British Columbia has been added to the Canadian section.

Straits Settlements and Federated Malay States.—Considerable progress has been made in the re-organisation of this Court, on a plan prepared last year by Professor Dunstan, which was approved by the Government of the Straits Settlements, by whom the work of collecting and preparing in the Colony the new exhibits required was entrusted to Mr. H. N. Ridley, M.A., Director of Botanic Gardens and Forests at Singapore. Much assistance has kindly been given by Mr. Leonard Wray, F.Z.S., Curator of the Government Museum at Perak, whilst on leave in this country.

The Straits Court is being re-modelled in accordance with the general scheme for the improvement of the Collections, the object in view being to render the exhibits of greater value to commercial

Notes on Recent Additions.

men, for educational progress, and as a means of bringing to public notice recent developments in economic research. To this end the specimens have been thoroughly overhauled and a representative series selected for exhibition. Temporary labels have been added giving information describing the collection and manufacture of important products, and the local uses of other products, many of which do not appear as exports. These temporary labels are being replaced as rapidly as possible by fuller, specially prepared, printed labels, and when this work is completed it will be possible for the visitor to learn, as completely as the specimens allow, the method of cultivation, collection and manufacture of the products, and the uses to which they are put.

The tin industry has received special treatment in view of its paramount importance, and a complete series of specimens and photographs, illustrating the modes of occurrence of the tin ores, the methods of mining and smelting, have been placed on exhibition with full descriptive labels.

The geology of the peninsula is illustrated by a set of specimens with notes on the occurrence, geological age, and economic importance of the several formations.

Rice, sago, sugar, rattan canes, gutta-percha, rubbers, dammar resins, fibres, gambier and other tanning materials, dye stuffs, spices, &c., are similarly represented by selected specimens and descriptions of their collection, manufacture and uses.

Statistical tables showing the area, population, revenue, expenditure, trade and exports, prepared by the Local Government, have been placed in the Court.

An important addition is a large map specially prepared for the Court, showing the several Settlements and States under British administration, the railways, and other features of interest.

When the new exhibits arrive and have been incorporated in the present collection the Court will give a full and accurate representation of the economic resources of the Straits Settlements and Federated Malay States, and prove an important factor in extending public knowledge of the country and furthering its commercial interests.

British North Borneo.—A collection of the commercial products of British North Borneo, including timbers, coal, rice, sago, sugar, coffee, cacao, pepper, tobacco and cigars, camphor, gutta-percha, dammars, cutch and gambier, is on view in the North Gallery.

Western Australia.—Furniture manufactured from the principal hardwoods of the State, chiefly Jarrah and Karri, illustrating the adaptability of these woods for mouldings and turned work, as well as their susceptibility of taking a high polish and finish, is shown in the North Gallery.

Queensland.—A collection of the more important products of Queensland, especially minerals, and a large number of photographs is shown in the North Gallery.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

MINERAL SURVEY OF CEYLON.

A mineral Survey of Ceylon, restricted to minerals of probable economic value, is at present being conducted at the request of the Government of Ceylon, with the co-operation of the Scientific and Technical Department of the Imperial Institute. Mr. A. K. Coomaraswamy, B.Sc. (Lond.), and Mr. James Parsons, B.Sc. (Lond.), have been despatched to the Colony with instructions to report upon the occurrence of minerals of economic importance, including those at present worked, such as graphite and mica, and to select and forward representative samples for chemical analysis, technical trials and commercial valuation by the Scientific and Technical Department of the Imperial Institute.

By this means the Government of Ceylon will be put in possession of accurate information with reference to the economic mineral resources of the Island, and such further steps as seem desirable will then be taken to pave the way for their commercial development. It is probable that, indirectly, the Survey will also be productive of results of scientific value.

I.—REPORTS ON RECENT INVESTIGATIONS.

The following notices have been selected from reports recently made by the Scientific and Technical Department:—

POISONOUS FODDER PLANTS AND FOOD GRAINS.

PHASEOLUS LUNATUS.

A general account of the investigation of poisonous fodder plants and food grains which is now being carried out in the Scientific and Technical Department of the Imperial Institute has been already given in this Bulletin (Vol. I., p. 11). Reference was then made to the seeds of the leguminous plant *Phaseolus lunatus*, which had been found to furnish prussic acid when moistened with water, and in this particular to resemble the Egyptian plants *Lotus arabicus* and *Sorghum vulgare*, whose toxic properties had already been the subject of investigation in the Department, and had been shown to be due in each case to prussic acid produced by the interaction, in the plant, of a glucoside and a ferment simultaneously present. The investigation of *Phaseolus lunatus* has now been completed, and a paper embodying the

Poisonous Fodder Plants and Food Grains.

principal scientific results of the work has been communicated to the Royal Society by Professor W. R. Dunstan, F.R.S., Director of the Imperial Institute, and Dr. T. A. Henry, and has been printed in the proceedings of the Royal Society.

Phaseolus lunatus is believed to be indigenous to South America, but is now generally grown throughout the tropics for the sale of its seeds which, as obtained from the cultivated plant, are employed as a vegetable. The plant itself has the general habit of the scarlet runner (*Phaseolus multifloris*) to which it is closely related. In the wild state it produces seeds which vary in colour from light brown to deep purple, whilst under partial cultivation the seeds are usually light brown or pink with a few purple spots, and when thoroughly cultivated they become much larger and the colour changes to a pale cream tint. Coincident with these changes of colour in the seed coat, the toxicity of the seeds decreases with cultivation. In Mauritius the plant is grown practically wild for use as green manure, since it shares with other leguminous plants the power of utilising the nitrogen of the air, and is therefore a cheap source of nitrogenous manure. The seeds, however, are markedly poisonous, and great care is taken to prevent cattle from eating them. In India, Burma, the Straits Settlements, and other tropical countries where *Phaseolus lunatus* is partially cultivated, the pink or light brown seeds are commonly eaten, but instances of poisoning by such seeds have been recorded, and attention has been directed by Mueller (*Select Extra Tropical Plants*) and by Watt (*Dict. Econ. Prod. Ind. Vol. VI., p.* 186) to the necessity of using only light coloured seeds and rejecting as possibly poisonous those bearing much of the purple colouration. In the case of the white seeds, known in commerce as "Lima or Duffin beans," furnished by the thoroughly cultivated plant no cases of poisoning have been recorded.

It must be understood that in the instances previously investigated the poison does not exist as such in the plant but is formed *in situ* as the result of a chemical action, which is induced between two constituents of the plant when these are brought into contact with each other by crushing and the addition of water. Instances of this kind are not uncommon among plants :—thus the seeds of the black mustard are not in themselves pungent but owe this property to the essential oil produced by the interaction of certain constituent substances in the presence of moisture. Similarly a mixture of essential oil of bitter almonds with prussic acid is a product of a chemical reaction brought about by the addition of water to crushed bitter almonds, and as has been shown by investigations conducted in this Department reactions of the same kind give rise to the formation of prussic acid when water is brought into contact with the crushed stems or leaves of the Egyptian plants *Lotus arabicus* and *Sorghum vulgare*.

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In all these cases the two constituents of the plant which react with each other are respectively a glucoside and an enzyme (unorganised ferment).

Glucosides are well-defined chemical substances which possess the property of undergoing decomposition with the production of glucose and at least one other substance usually of the nature of an acid or alcohol. In some cases, however, such as that now under discussion a third substance is formed and, as the investigation now proceeding in this Department has already indicated, there exists a distinct class of glucosides of comparatively wide distribution in the vegetable kingdom in which this third product is always prussic acid. To distinguish this group the adjective "cyanogenetic" has been suggested. The following glucosides of this type are at present known:—

Name.	Origin.
Amygdalin ...	... Seeds of *Prunus amygdalus* var. *amara* (Bitter almond).
Lotusin ...	... Stems and leaves of immature *Lotus arabicus* (Khuther).
Dhurrin ...	... " " " *Sorghum vulgare* (Dhurra).

The other constituents concerned in the production of prussic acid in these plants—the enzymes—form a group of substances about which comparatively little is known, although many of the most important changes in the economy of animals and plants are brought about by their agency, and their activities are constantly utilised in important industrial operations. They are of common occurrence in plants, thus one of the best known enzymes—diastase—occurs in malt and in many starchy seeds and is the active agent in converting the insoluble material, starch, into a soluble sugar which can be utilised as nutriment by the young plant. Other enzymes are constantly associated with plants of the lowest type thus, *invertase* and *zymase* always occur in yeast cells, and are the agents to which the yeast plant really owes its property of decomposing the more complex sugars into glucose and of converting the latter into alcohol and carbonic acid gas. The plants referred to above as containing cyanogenetic glucosides have each been found to contain in addition, the enzyme appropriate for the decomposition of the glucoside. In most cases this enzyme may be regarded as closely allied to, if not identical with, the *emulsin* of almonds.

The observations already recorded as to the properties of the seeds of *Phaseolus lunatus* rendered it probable that they contained a cyanogenetic glucoside together with an enzyme. A supply of the seeds from Mauritius was obtained through the kindness of M. Boname, Director of the Agricultural Station at Mauritius, who collected the material at the instance of the Colonial Office.

Preliminary experiments showed that the seeds liberated prussic acid in the course of a few minutes after being crushed and moistened with water. Determinations were made of the amount

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of prussic acid obtainable from the seeds in this way, and it was found that it varied with the colour of the seed—very light brown seeds furnishing about 0·04 per cent., and the deep purple seeds as much as 0·08 per cent. These seeds are bitter to the taste, and are by this means readily distinguishable from the seeds of cultivated plants. Further investigation has shown that the seeds from Mauritius contain a new cyanogenetic glucoside to which the name *phaseolunatin* has been given. This substance crystallises in colourless needles, is very soluble in water, and when boiled in aqueous solution with dilute mineral acids is decomposed with the formation of *glucose, acetone* and *prussic acid.* The same decomposition is brought about when a small quantity of the enzyme *emulsin,* prepared from sweet almonds, is allowed to stand with an aqueous solution of phaseolunatin. Further experiments were made in order to isolate the enzyme, to whose activity the decomposition of the glucoside in the cells of the plant appeared to be due, and eventually preparations of an enzyme were obtained which when added to aqueous solutions of phaseolunatin induced its characteristic decomposition. As these preparations also readily decomposed amygdalin, the glucoside of bitter almonds and salicin, a glucoside found in willow bark, and as both these reactions are characteristic of *emulsin;* the enzyme of *Phaseolus lunatus* seeds may provisionally be regarded as identical with this substance.

The toxicity of these seeds must, therefore, be attributed to the formation of prussic acid as the result of the decomposition of the glucoside phaseolunatin *by the enzyme* emulsin *in the presence of water.*

RANGOON, PAIGYA OR BURMA BEANS.

The purple-spotted, pink beans obtained from partially cultivated *Phaseolus lunatus,* as has already been pointed out, although occasionally poisonous, are commonly eaten in the tropics as a vegetable, and it appears to have been this variety of seeds which has been of late largely imported into this country from India under the names of Rangoon, Paigya or Burma beans, to be used as a cattle fodder. Samples of these beans were sent to the Scientific and Technical Department of the Imperial Institute by various merchants in London and the provinces, with a request for an opinion as to their nature and suitability as cattle food. It was found that the Burma beans furnished very small and varying quantities of prussic acid. The amount of this acid formed in most cases was probably insufficient to be dangerous to cattle, but in view of the fact that the amount of prussic acid formed varies with different specimens of seed, it seems desirable that the use of these Indian seeds as a feeding-stuff should be attended with caution until it has been ascertained precisely under what conditions they are poisonous.

Poisonous Fodder Plants and Food Grains.

GENERAL CONSIDERATIONS.

The chemical investigation of these various poisonous fodders in the Scientific and Technical Department of the Imperial Institute has already been productive of useful practical results in various ways: thus, it has been shown that the Egyptian weed, *Lotus arabicus*, although poisonous in the immature state, loses this property as it ripens, and eventually becomes a harmless and, indeed, nutritious fodder. Similarly, the reason for the toxicity of immature or badly nourished plants of *Sorghum vulgare*, which has long puzzled veterinary surgeons and others in India, Australia, Egypt and other countries where the plant is grown, has been elucidated, and the conditions under which the plant may be safely used as a fodder ascertained. These results have since been amply confirmed and extended by Brünnich, of the Queensland Agricultural Department (Journ. Chem. Soc., 1903, 788). The Imperial Institute is still engaged in the examination of a numbe of other plants presenting similar characteristics, and it is propos to publish accounts of the results obtained in these cases so as the various investigations are completed. In the meantim Scientific and Technical Department will be glad to receiv any of the Colonies specimens of poisonous fodder plant food grains, so that this investigation may be rendered as complete and far-reaching as possible.

ASPHALT ROCK FROM THE ISLAND OF BAHREIN, PERSIAN GULF.

The discovery of a deposit of asphalt rock in Bahrein was reported to the Government of India in February, 1902. A sample of the material was submitted for examination in the same year to the Director of the Geological Survey of India, who made a preliminary report, stating that it could probably be used as a paving asphalt. In July, 1902, His Excellency the Viceroy of India suggested that a sample should be sent for complete examination and valuation to the Imperial Institute.

About 2 cwts. of the asphalt rock were received, through the India Office, in February, 1903, and the material has been fully examined in the Scientific and Technical Department, and afterwards valued by experts. The sample consisted of large pieces, externally hard, slightly sticky and brown, and internally somewhat soft and quite black. The material had the characteristic odour of asphalt.

Asphalt Rock from the Island of Bahrein. Persian Gulf.

A fair sample of the whole was submitted to analysis when the following results were obtained:—

Moisture	0·59	per cent.
Volatile matter	17·47	,,
Fixed carbon	5·30	,,
Ash	76·63	,,

The amount of bitumen contained in the asphalt rock was determined by extraction, first with acetone to remove the liquid bituminous matter (petrolene), and subsequently with chloroform which dissolves out the solid bitumen (asphaltene).

Matter soluble in acetone (petrolene) ...	10·47	per cent.
Matter soluble in chloroform (asphaltene)	7·20	,,
Total bituminous matter	17·67	,,

The composition of the mineral matter of asphalt rock is of some importance in determining the nature of the diluent to be used in the preparation from it of standard paving asphalt. The ash of the Bahrein product has the following composition:—

Silica	SiO_2	66·24	per cent.
Alumina	Al_2O_3	9·54	,,
Ferric oxide ...	Fe_2O_3	2·31	,,
Magnesia... ...	MgO	2·22	,,
Lime	CaO	15·78	,,
Soda	Na_2O	2·20	,,
Potash	K_2O	1·65	,,

Laboratory tests were made to ascertain whether the mineral could be used as a paving material, and it was found that by dilution with 75 per cent. of its weight of powdered calcite it could be converted, by the application of heat and pressure, into a hard impermeable substance quite suitable for the purpose mentioned.

The composition and probable uses of the material having been thus determined, samples were submitted for inspection and practical trial to two firms trading in asphalt. These firms both report that the material is of excellent quality. One firm states that it is equal to the La Brea deposit of Trinidad and superior to those of Venezuela and Columbia. It could be employed for the preparation of asphalt pavements of all kinds and could probably also be used as an insulating medium for electrical purposes. For use as a paving material it would require to be ground and mixed with a suitable diluent (*e.g.*, powdered limestone or calcite), so that the mixture should contain from 8 to 10 per cent. of bituminous matter. In this state its value in London would be from 2*l.* to 2*l.* 5*s.* per ton. At this price the export of Bahrein asphalt to Europe would probably not prove remunerative, but it may be pointed out that considerable quantities of paving asphalt

Asphalt Rock from the Island of Bahrein, Persian Gulf.

are at present imported into India from European countries, especially from Germany and France, and that there would appear to be no reason why Bahrein asphalt, if obtainable in sufficient quantity of the same quality, should not displace these imports.

Attention may also be drawn to the fact that this deposit is not only intrinsically valuable but that such deposits indicate the probable existence in former times in this neighbourhood of other products of the nature of petroleum. It is desirable that this point should be borne in mind in any further examination of this district which may be made.

GUTTA PERCHA OF *PALAQUIUM PETIOLARE* FROM CEYLON.

These samples of gutta percha were forwarded for examination from Ceylon. It was stated that the specimens had been collected from one species of tree only, viz., *Palaquium petiolare*, Engl., growing at Hinidoon Kanda, South-West Ceylon, and that the supply would be almost unlimited. Three distinct samples, prepared by different methods, were submitted:—

(*a*) "20 balls, each prepared by rubbing the latex in palm of hand, during October, 1901."

(*b*) "1 ball prepared by rubbing in palm of hand after the greater part of the water had been driven off by slow heating for two hours, on 25th October, 1901."

(*c*) "Thin layers prepared by evaporation at ordinary temperature of air. Exposed to air for over three months."

Description of the samples.

(*a*) The balls ranged from 1 to 2 inches in diameter and had a smooth shining surface; externally the colour varied from yellowish-white to brown, but internally the freshly broken surface was milk-white, turning yellowish-white on exposure to the air; the fracture was smooth and the balls were quite free from foreign vegetable matter; when whole they had no odour, but when freshly broken a slight sour smell was noticed. The balls were fairly hard and withstood a sharp blow without fracture, but small pieces were rather friable and showed no toughness; the material was easily reduced to coarse powder in a mortar. On holding a piece in the hand it softened so that it could be moulded, and on immersion in hot water it became very sticky and plastic; after the latter treatment the mass took some time to harden, and at the end of two days it was still fairly flexible.

(*b*) The ball was about 2 inches in diameter and was almost

Gutta Percha of Palaquium Petiolare from Ceylon.

identical in appearance and properties with sample (*a*). The only differences noticed were that on standing exposed to the air it developed a slight reddish tinge, which was afterwards lost as it gradually darkened, and that after softening in water it took longer to harden.

(*c*) This was an aggregated mass formed of thin plates of the gutta which had adhered together; these were dark brown in colour externally but nearly white within. The plates were brittle, breaking easily with a smooth fracture, but when held in the hand they softened so that they could be bent without breaking, and finally could be moulded in the fingers. In other respects it resembled sample (*a*), but took longer to harden after immersion in hot water.

Chemical Examination.—The three samples as received had the following composition—

	a		*b*		*c*
	Per cent.		Per cent.		Per cent.
Moisture	9·6	...	5·0	...	1·3
Resin	62·3	...	68·6	...	68·0
Gutta ?	24·6	...	25·0	...	25·1
Dirt	3·5	...	1·4	...	5·6
Ash (included in dirt)	1·05	...	0·65	...	1·25

For purposes of comparison the percentages of resin, gutta and dirt may be expressed on the dry material as follows :—

	a		*b*		*c*
	Per cent.		Per cent.		Per cent.
Resin	68·9	...	72·2	...	68·9
Gutta? ...	27·2	...	26·3	...	25·5
Dirt	3·9	...	1·5	...	5·6

These results show that the samples are very uniform in composition, the only considerable variation being in the amount of insoluble matter (dirt) present. Sample (*b*) which had been prepared by heating contained the largest amount of resin, but otherwise the different methods of preparation had apparently little influence upon the composition of the product.

It was clear from the physical properties of the samples that the gutta percha is of inferior quality, and this opinion was confirmed by the large percentage of resinous substances found on analysis. Moreover, the "gutta" obtained from it did not exhibit the characteristic properties of the substance from true gutta percha, being friable, devoid of strength, and softening when held in the fingers. In fact no true gutta was present in any of the samples.

Material such as this possesses no value for insulating purposes, and the brokers to whom it was submitted for commercial valuation stated that it would only be worth about 1½*d.* per lb.

RUBBER OF *URCEOLA ESCULENTA* FROM BURMA.

This sample of rubber (No. 14,452) derived from *Urceola esculenta* was collected in Rangoon.

The specimen was an irregular mass of rubber, almost black in colour externally but presenting a mottled appearance when cut, being nearly white in places. The mass was very hard and showed no stickiness; it was slightly porous, and contained a quantity of vegetable matter distributed through it. Small pieces of the rubber showed good elasticity and tenacity.

It furnished the following results on chemical examination :—

	Sample as received. Per cent.	Calculated on dry material. Per cent.
Moisture	6·9	—
Resin	7·0	7·5
Caoutchouc	76·2	81·8
Dirt	9·9	10·7
Ash (included in dirt).	1·7	1·8

These results show that the rubber is of very fair quality, though the amount of insoluble matter (dirt) is rather high. This, however, could be remedied to a large extent by more careful collection so as to exclude vegetable debris.

A sample of the rubber has been submitted for commercial valuation to brokers who compare it with "Tonquin" rubber worth about 2*s.* or 2*s.* 1*d.* per lb. They state, however, that large consignments of this type of rubber rarely arrive in such good condition as the present sample, being usually more or less damaged by changes occurring during transport, in which case the value would be considerably reduced, and sales more difficult to effect.

This material is evidently deserving of further attention.

FIBRE OF *AGAVE AMERICANA* FROM ASSAM.

This sample of *Agave americana* fibre (No. 16,260) is stated to have been obtained from Cachar, Assam.

The fibre was coarse, but clean, and of good appearance, yellowish-white in colour, and possessed a fine gloss; it was moderately strong, and the average length of staple was 3 feet 8 inches.

The results of the chemical examination are given below,

Fibre of Agave americana from Assam.

together with those of a previous analysis by Messrs. Cross & Bevan of another specimen of the same fibre grown in India.

		Fibre No. 16,260.	Fibre analysed by Cross & Bevan.
Moisture	per cent.	9·7 ...	10·5
Ash	„	1·5 ...	1·4
Loss on (*a*) hydrolysis ...	„	9·8 ...	10·0
„ „ (*b*) „ ...	„	15·7 ...	20·0
„ „ mercerising ...	„	7·1 ...	11·0
„ „ acid purification ...	„	2·4 ...	1·1
Gain on nitration	„	34·0 ...	9·8
Cellulose	„	79·6 ...	75·8
Length of ultimate fibre...	...	2-4 mm.	

These results indicate that the present specimen is of much better quality than that previously examined by Messrs. Cross & Bevan. The present sample contains a higher percentage of true cellulose and would probably be rather more durable.

Representative samples of the fibre have been submitted to two leading firms of fibre brokers for commercial valuation. The fibre is reported to be of good quality but is rather too dry and brittle; its strength, colour, and length are all described as fairly satisfactory. The defects are probably due to faulty methods of preparation. Portions of the sample are of very good quality, being equal to ordinary Sisal hemp from the West Indies and would realise about the same price, which ranges at the present time from 35*l.* to 38*l.* per ton. It is to be remembered, however, that this price is much higher than the average, which may be taken at about 20*l.* to 25*l.* per ton. A trial shipment of one or two tons is recommended, so that spinning and other trials can be made. If these should prove satisfactory, it is stated that large quantities could be sold at current prices, fluctuating with the price of Manilla hemp.

It is evident from these reports that, properly prepared, the fibre of *Agave americana* would compare favourably in commerce with ordinary Sisal hemp and would probably command good prices on the London market.

FIBRE OF *MARSDENIA TENACISSIMA* FROM BENGAL.

A sample of the fibre of *Marsdenia tenacissima*, shown at the Colonial and Indian Exhibition of 1886, was examined by Messrs. Cross & Bevan, who reported that it was of excellent quality, and that in point of fineness and durability it ranked next to Rhea fibre (Report on Indian fibres, p. 33).

Since it appeared desirable to investigate more fully the properties and possible applications of this fibre, the Imperial Institute

Fibre of Marsdenia tenacissima from Bengal.

requested the Reporter on Economic Products to procure a sample for this purpose. Considerable difficulty was experienced in India in collecting an authentic specimen of the fibre, but a sample (No. 16,080) was eventually forwarded, with the information that the plant is fairly abundant in the Rajmahal Hills, but that the process of extracting the fibre is both tedious and laborious, being mainly carried on by hand-stripping.

The sample consisted of a very strong, fairly white fibre, with a staple of an average length of 12 to 13 inches. The results of its chemical examination in the Scientific and Technical Department of the Imperial Institute are given below, and also those of Messrs. Cross & Bevan, obtained from the former sample :—

	Sample No. 16,080. Per Cent.	Sample examined by Cross & Bevan. Per Cent.
Moisture	7·7	4·5
Ash	1·5	1·5
Loss on (*a*) hydrolysis	7·8	6·2
„ (*b*) „	8·9	10·1
„ mercerising	4·9	4·6
„ acid purification	3·5	0·8
Gain on nitration	53·9	31·0
Cellulose	91·5	88·3
Length of ultimate fibre	10-30 mm.	5-20 mm.

The fibre contains little or no lignocellulose; this being shown especially by the absence of colour in the nitration product, and by the fact that when the chlorinated product, obtained in the course of the estimation of cellulose, is treated with sodium sulphite no red coloration is produced. It is exceptionally resistant to the action of alkali as is indicated by the comparatively small losses sustained on hydrolysis and mercerising. The remarkable quality of this fibre is shown also by the unusually high percentage of cellulose and by the large increase of weight on nitration.

The present specimen is seen to be of better quality than that examined by Messrs. Cross & Bevan; it is richer in cellulose and shows a much larger increase of weight on nitration, whilst the average length of the ultimate fibre is also somewhat greater.

Representative specimens of the fibre have been submitted to two leading firms of fibre brokers for commercial valuation. One firm reports that the fibre, although short, is of great strength and therefore likely to be of value. It is suggested that sample bales should be sent for trial. The other firm reports that the fibre is very strong but harsh. It is too short for machine spinning and consequently could only be utilised as tow. The sample is said to be worth from 15*l.* to 18*l.* per ton (of a length of 12 to 15 inches); if, however, the fibre could be sent of a length of 30 to 50 inches, its value would probably be from 35*l.* to 40*l.* per ton.

Fibre of Marsdenia tenacissima from Bengal.

From the foregoing reports it is seen that the fibre is one which might be of importance, whilst the chemical examination shows that it possesses properties which are considerably above the average of those of ordinary fibres. In view of the results obtained it seems desirable to consider whether experiments in cultivating the plant should be undertaken, as it is understood to be of comparatively rare occurrence in India, and also to determine whether the fibre could be successfully treated by machinery.

COTTON FROM RHODESIA.

Samples of cotton, grown in Rhodesia, were forwarded by the Agricultural Department at Salisbury, and were transmitted by the British South Africa Company to the Imperial Institute for examination and valuation.

Three samples, labelled 1, 2, and 3 respectively, were received; Nos. 1 and 2 were obtained from Mashonaland and No. 3 from North Eastern Rhodesia. They were very small specimens, and the seeds had not been removed from No. 1 and No. 2.

The samples have been submitted to brokers for commercial valuation, and the reports furnished are incorporated in the following descriptions:—

No. 1. Label:—"Mashonaland Cotton. 17/8/01."

This is a silky and fairly strong cotton, the staple of which is of average length; it is white in colour, but contains a small proportion which is stained yellow. Properly cleaned specimens, represented by the white cotton, are valued at 6*d.* per lb. on the spot; but the presence of stained cotton would reduce the value, and, on this account, 5½*d.* per lb. is quoted for cotton represented by the sample as a whole.

No. 2. Label:—"Zambesi Cotton. 16/8/01."

This is a strong, silky cotton, of good length; it is bluish-white in colour, and a little stained. If properly cleaned, its value is given at 6½*d.* per lb. on the spot.

No. 3. Label:—"Sample of Cotton from Loangwa Mountains 17/8/01."

This sample is Kapok not cotton. This material is chiefly used in this country for upholstering purposes since, owing to the very short staple, it is difficult to spin. It is, however, utilised for textile purposes in Germany and Holland. The sample is too small to enable a definite valuation to be given, but it would probably be worth about 3½*d.* to 4*d.* per lb. on the spot.

The brokers add that the above valuations for the cotton are based on the assumption that the seeds would be removed and the cotton properly cleaned. They state that the seed itself if properly cleaned would probably be worth about 4*l.* 5*s.* per ton.

II.—GENERAL NOTICES.

(Prepared by the Scientific and Technical Department.)

THE ECONOMIC DEVELOPMENT OF GERMAN EAST AFRICA.

The Protectorate of German East Africa on its northern frontier adjoins British East Africa and Uganda, on its western frontier the Congo Free State, on its south-western frontier North-Eastern Rhodesia and British Central Africa, and on its eastern frontier Portuguese East Africa.

With regard to the physical structure of the country, it is noticeable that the rivers of the west of German East Africa flow to three different seas: waters flowing northward into the Victoria Nyanza pass down the Nile to the Mediterranean Sea; other waters from the same neighbourhood, near Tabora, flow westward through Lake Tanganyika down the Congo to the Atlantic; Lake Nyassa drains southward to the Indian Ocean. A region capable of starting on their downward course two rivers each exceeding 2,000 miles in length (Congo and Nile) necessarily has land of some altitude. German East Africa is for the most part a hilly upland—a country of vast plateaux, grassy and undulating, with intervening valleys. There is only a narrow strip of maritime lowland, which broadens out somewhat to the west, where it is entered by the valleys of the Ruvuma, Rufiji, and Pangani rivers.

The population of German East Africa in 1901 comprised about 6,000,000 African natives, 3,400 Indians, 2,600 Arabs, 2,000 German troops and police, 995 German residents, and 63 English.

German possession of the territory began in 1884, when the German East Africa Company obtained from native chiefs the control of land on the coast, and therefore easy of access. The coast districts have developed more rapidly, among the most advanced being Tanga, Wilhelmstal, Saadani, Bagamoyo, Dar-es-Salaam, Kilwa, Lindi; other places of importance, Langenburg, Bismarckburg, Ujiji, Mwansa, are on the shores of the great lakes; while Tabora, Kilimatinde, Mpapua, and Kilossa are on the caravan route from the lakes to the coast.

Planting is encouraged by the German colonial authorities through local bodies combining administrative powers with the duty of developing agriculture. In 1901 certain districts—

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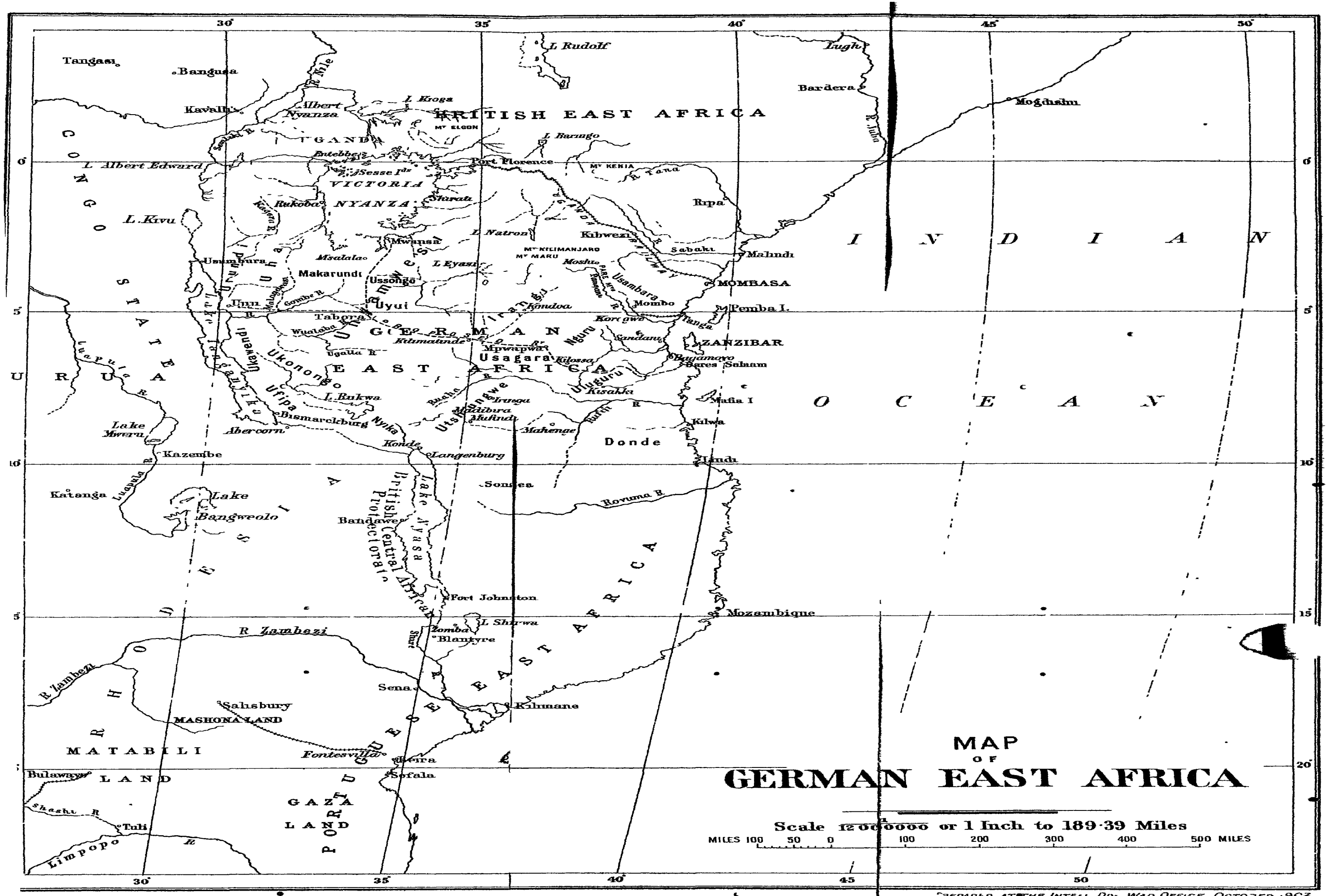
Tanga, Wilhelmstal, Pangani, Bagamoyo, Dar-es-Salaam, Kilwa, Lindi, Langenburg, Kilossa—were constituted "communes" governed by a council having control of communal funds derived from a hut-tax and a trade-tax.

The following particulars are taken from a report for 1903 on the "Agriculture and Forestry of German East Africa" (Berichte über Land und Forstwirtschaft in Deutsch-Ostafrika), published by the Government of the Protectorate. Of the information relating to the several districts, it is worthy of note that a considerable portion has been contributed by military officers commanding posts in the interior, and it appears that to their efforts is largely due the progress that has been made.

In addition to difficulties caused by such tribes as the Masai, serious obstacles have been encountered in the form of drought, locusts, famine, Texas-fever among the live-stock, disease of the matama crops, and coffee-leaf disease, which have been severely felt in certain districts. Progress is checked, however, most of all by the want of railways. There is in German East Africa no railway except the comparatively short line, 54 miles in length, from Tanga to Korogwe, now being extended 27 miles to Mombo. For the whole of the rest of the Protectorate there is no means of land communication other than the roads and the old caravan routes. Of the latter, the most important is the one mentioned above, and by it ivory and rubber still come, though in decreasing quantities, to the coast at Dar-es-Salaam, for shipment to Europe.

Two agricultural experiment stations have been started. One of these is at Dar-es-Salaam, the capital of the Colony. Only lowland plants can be grown there, and the site having proved unsuitable, a third station is about to be established in the eastern part of Usambara, at an elevation of 2,500 ft. above sea-level. The second agricultural station already established is at Mombo, in the western part of Usambara, at an elevation of 1,400 ft. Here are grown experimentally several acres of Egyptian cotton, while Sea-Island, Indian, and other kinds of cotton are being tried on a small scale; rice, ramie, pulse crops, vegetables, fruits, caoutchouc (chiefly *Castilloa elastica*) and timber trees are also under experimental cultivation. The agricultural stations received during the year seeds and plants from the botanic gardens of Berlin, India, Ceylon and Java, and distributed to communal and other local authorities, and to individuals, 3,470 sets of seeds or plants. These included the trees *Albizzia Lebbek*, *Poinciana regia*, *Adenanthera pavonina*, *Melia Azedarach*: the fruit trees *Anona muricata*, *Eugenia jambolana*, Cashew, Mango: the Caoutchouc-plants, *Manihot Glaziovii*, *Ficus elastica*, *Mascarenhasia*



MAP OF GERMAN EAST AFRICA

Scale 1/12000000 or 1 Inch to 189·39 Miles

Prepared at the Intell. Div., War Office, October, 1903

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elastica, Cryptostegia grandiflora, Landolphia: plants yielding tanning materials and gums, *Caesalpinia coriaria* (Divi-divi), *Acacia leucophlœa, Acacia decurrens*: and the timber trees, *Santalum album, Cassia florida, Acacia dealbata, Acacia melanoxylon*, Teak, Eucalyptus.

1.—Tanga.

The staple foods of the inhabitants of this coast-province have long been:—

In the true Coast-Lands	Matama (Sorghum).
„ Digo-Land, which lies between the Coast and the Usambara Mountains	Manioc (Cassava).
„ Bondei-Land, which lies between the Usambara Mountains and the Pangani River	Maize.
„ Usambara Mountains	Bananas.

Among foods less extensively cultivated are chirokko (*Phaseolus Mungo*), rice, beans, and sweet potatoes, the latter being largely grown by the Wanyamwesi settlers on the coast-lands.

The inhabitants are by no means adequately equipped with agricultural implements, and have only one that answers its purpose at all well—a tool for cutting bush and small wood. Two other implements are in general use, but both are inefficient; a small hoe, which does not go deep enough to properly till the soil, and a hatchet so worthless that, in cutting down large trees, the natives resort to the use of fire. Steps are being taken to introduce better implements, and to induce the natives to use them.

In the conversion of bush-land into fields fire plays a prominent part, and charred stumps as well as roots are allowed to remain even for years in the corn-fields, so that these have the appearance of being only half cleared. Soil containing ash supplied by burning the bush is fertile for the first year or two, but the soil afterwards becomes exhausted, and the inhabitants, who know nothing of manuring, move to and exhaust one spot after another.

It is stated that the natives practise an elementary form of rotation. In many cases the crop which they cultivate first is "matama" (sorghum) and the last crop manioc (cassava), for they are aware that the latter grows fairly well even in an exhausted soil. After about five years the land is no longer capable of bearing cereal crops, and is planted up with cocoanuts and bananas.

The principal crops are as follows:—

Matama (Sorghum).—The cultivation of matama almost ceased during 1895-1900, when drought and locusts caused

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failure of this and other crops, and a famine which reduced the population of the province by one-half. But it is expected that matama will soon become abundant again, the coast-lands being very well adapted to it. In former times matama was exported from these districts to Arabia. The province of Tanga is free from the so-called mafuta-disease which destroys the matama crops in some provinces. There are two principal varieties of matama, the white and the red, and of these the white variety is the one most widely cultivated here. Both kinds like a strong loam. The corn is sown in the first "little rainy season" (March) which precedes the "great rainy season," and the crop is subsequently weeded only once. The corn is threshed with sticks. An average crop yields 80 zentner* per hectare,† and the local price varies from 4 to 7 marks per zentner.

Maize.—White maize is the variety most generally cultivated. It is grown in almost all parts of the province, and does particularly well in the rich loam soils of Bondei-land. The crop has no definite seed-time, and can be sown during any of the three "little rainy seasons" (March, July and December), but should not be sown during the "great rainy season" (May). The yield of maize is about two-thirds of that of matama, and the price, at present, about the same as that of the latter (7 marks), though usually maize is somewhat lower.

Manioc.—Of this plant, which yields the crude flour known in western countries as cassava and the purified flour tapioca—four varieties are here cultivated. One of these, known as *Mohogo ya kisungu*, ripens in six weeks, while the other varieties take nearly five months to ripen. Manioc thrives best in a light soil, and such soils are common in Digo-land. The chief enemy of manioc is excessive rain. On lands occupied by natives the yield is about 40 zentners per hectare, and when it is in a dry state the average price is 7 marks per zentner.

Bananas.—These are cultivated in every part of the province, where at least eleven different varieties are known. At present the fruit is grown only for the local market, but as soon as an export trade is developed it will be possible to greatly increase the production. Bananas grow in various soils and situations, and, as stated above, exhausted cornfields are usually planted with them. On the coast they are eaten raw or cooked, while in Usambara, where they are the chief food of the people, they are generally dried and made into meal, which will keep for about five months.

Chirokko (*Phaseolus Mungo*).—Chirokko will grow in almost any soil, and requires only two months to come to maturity.

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* Zentner = 110 lbs. † Hectare = 2½ acres.

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The price is about 7 marks per zentner, and lands occupied by natives produce about 10 zentners per hectare.

Rice.—Large numbers of Indian coolies are now resident in German East Africa, and to their presence is due the fact that the African natives are taking to rice, which the planters hope they will adopt as a staple food on the plantations. Rice is now cultivated in the neighbourhood of the town of Tanga and in Boudei-land, exclusively in low-lying lands which are submerged during the principal rainy season. To get the crop in and well up before the heavy rains begin, it is found necessary to sow it during the first "little rainy season," so that when the heavy rains come and the fields are submerged, the stalks reach to the surface of the water. Rice, however, is not likely to be cultivated extensively except where it is possible to irrigate the crop from rivers and springs, and to control flood-water by means of dams and trenches. The local value of rice is about 11 marks per zentner.

Sweet-Potato (Batatas).—The Wanyamwesi cultivate sweet potatoes with a considerable amount of care, by forming furrows and ridges 1 ft. 6 in. in height, the grass on the sods being turned inwards. Subsequently, the ridges are turned again, the ridges and furrows changing places. The fields then look as if they had been ploughed, not worked with a hoe. Sweet potatoes are the cheapest food in the town of Tanga. A zentner costs about 2 marks.

Cocoanut.—These palms are grown in the coast-lands of the province in sand or sandy loam. It is estimated that there are at least half-a-million cocoanut trees in the province, without counting 300,000 lately planted on estates owned by Europeans and expected to come into bearing two years hence. Instead of annually increasing the area planters are cultivating more intensively the existing area under palms, seeking to fully occupy the land by growing fibre-plants in the cocoanut plantations. About one quarter of the cocoanut crop is used locally, and its total value last year was estimated at 200,000 rupees. Copra to the value of 143,000 rupees was exported. On lands occupied by natives the cocoanut trees are in a neglected condition owing to the fact that during the famine nearly half the villages were abandoned, and the palms now remain untended. But on even moderately well kept native holdings 100 palms, occupying one or two acres, suffice to supply a family with food. To check the ravages of a beetle, which often attacks the palms, the natives scatter loose sand upon the growing bud. It is estimated that 100 nuts will yield 35 lbs. of copra, worth 3½ marks. The cocoanut plantations supervised by the communal authorities are improving, and last

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year there was a considerable increase in the production of copra.

Sesamé seed is cultivated for its oil. Only the dark variety is grown here, and the seed-time is in July and December. It requires rain until it is about 2 ft. high, and then dry weather, and comes to maturity about five months after sowing. The plant is sometimes very productive, but very uncertain. Last year the harvest was poor owing to the dry season having set in too early, and the value of the sesamé export was only 20,000 rupees.

The above facts indicate that the prices of foods are remarkably high; indeed, bread-stuffs are as dear as in Europe. This is attributed to ignorance of the value of money on the part of the natives, who grow only enough for their immediate wants, make no provision for the future, and do not realise that the possession of money would enable them to buy food. The people are also exceedingly indolent. While only one per cent. of the land in Tanga province is cultivated, rice of the value of 400,000 rupees was imported from India last year. It is pointed out that the country could at least render itself independent of other countries so far as its own need of foodstuffs is concerned.

Coffee Plantations.—The coffee plantations in the hands of German proprietors in Tanga province have 4,000,000 coffee-trees, of which, at present, 1,500,000 are bearing. Last year the crop yielded 4,000 zentner of coffee, representing a value of 200,000 rupees. In the first few years of coffee-planting grave mistakes were made by the establishment of plantations upon unsuitable spots. For recently formed estates the sites have been more carefully chosen. Coffee-leaf disease made its appearance in German East Africa soon after the first establishment of coffee plantations, but has caused less injury than was anticipated.

Tanga province, though the most advanced, is by far the smallest of all the provinces in the Protectorate, and therefore its revenue is small. Owing to the reduction of the population by famine during the years 1897–99, half the huts are uninhabited, and the finances of the province—depending, as they do, upon the hut-tax—are in a precarious condition.

The town of Tanga, in addition to being the first stopping-place for Europeans arriving in German East Africa from Europe, is the terminus of the railway, and the chief centre for exportation of coffee, almost all the coffee plantations being in Usambara. For these reasons, it is very desirable that the labouring population of Tanga province should not be allowed to further decrease. It is recognised that it would be unwise to wait until re-population takes place in the course of time.

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Measures are therefore being taken by the communal authorities to form settlements, and these are of two kinds: (1) Settlements, on the coast, of African (Wanyamwesi) natives brought from the interior; (2) Settlements, on the coast, of Indians, near to the Wanyamwesi. The former is the more important form of settlement in point of numbers, and it is hoped that the presence of Indians will tend to improve the quality of the labour, and that the Wanyamwesi will learn from the Indians more careful methods of cultivation. Implements are distributed, and better huts are being erected, to induce the settlers to remain in the settlement instead of wandering from place to place.

Severe losses of live-stock have occurred in the coast districts of Tanga, Texas fever having during the last few years killed off more than half the cattle. The remaining animals, having become "salted," are highly valued. In the experimental plantations on the communal lands of Tanga there have been planted 32,000 Johore trees (*Cassia florida*), 25,000 Teak, and the following plants in smaller numbers:—*Ficus elastica, Cassia angustifolia, Dalbergia latifolia, Manihot Glaziovii, Dendrocalamus strictus, Eugenia moluccensis, Arundinaria falconeri, Acacia arabica, Acacia catechu, Santalum album, Ficus indica, Caesalpinia coriaria, Albizzia Lebbek, Baxhia Kirkii,* "Mgongo," Papaw, Opuntia, Manioc, Sumatra tobacco.

2. WILHELMSTAL.

Wilhelmstal is in the Usambara Mountains on an old caravan route leading from Mount Kilimanjaro to the coast. Produce has to be brought down to Korogwe, and is there put on the railway and sent to Tanga for exportation. Wilhelmstal is at present the principal coffee-growing district in German East Africa, and coffee is the most important crop grown by Europeans. There are five large plantations, and a sixth is just coming into bearing, 12,000 coffee-trees having been planted upon it a few years ago: of these, 2,000 are already bearing, and the remaining 10,000 were coming on well, and expected to bear during the year. The Balangai coffee-plantation has 300,000 coffee-trees, of which 130,000 began to bear for the first time last year. About 100 more acres were being planted with 100,000 trees in 1902, after the "great rainy season." The crop is very promising, some of the trees having each about 500 flowers and fruits, and this should give a yield of $\frac{3}{4}$ lb. of coffee per tree as a first crop. The methods of coffee-planting in use have been initiated by a local planter with experience of coffee-planting in Sumatra. Some 700 natives are employed on the estate. In this district there is abundance of food for them, as they sow their food-crops at the right season. The Balangai district is 4,000 ft.

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above sea-level, and during last year had 194 rainy days. The main difficulty with which European coffee-planters have to contend is the want of good means of communication to supply an outlet for their produce. The Herkulu plantation has 200 acres planted with 220,000 trees of Arabian and American species of coffee. A new plantation is being formed which will have 150,000 trees of Central American coffee. The Mazumbai plantation, in the same neighbourhood, is planted with Arabian coffee.

Where the mountain-slopes are bare, afforestation has been begun with eucalypts and acacias, both of which grow well here. Experiments with pines and oaks have been unsuccessful.

A new industry—swine breeding—is being started in Wilhelmstal. The sweet potato furnishes an excellent and very cheap pig-food. It is hoped that an export trade in bacon to Zanzibar and South Africa will be developed.

3. Pangani.

The natives of this province are traders rather than agriculturists, and look upon field labour as an occupation fit only for slaves or women. Work in the fields is often entirely suspended so long as a remnant of the last year's harvest remains. But on the other hand the natives are great cattle breeders. The caravan route from Kilimanjaro passes through the district, and used to be much frequented. Cattle, slaves, and ivory could be readily sold at a profit on the coast. Owing to the abolition of slavery, and the decrease in the supply of ivory caused by the destruction of elephants, the natives in the interior have no occupation left but cattle breeding. Cattle, sheep, goats and asses are bred by them in such quantities that the supply of these now exceeds the demand on the coast. Texas-fever has wrought havoc among the cattle in the coast lands, so that cattle breeding is impracticable, and the only occupation of the natives there is tillage of the soil. The rainfall has been sufficient to enable them to grow enough matama for their own needs, and to spare some for sale in the famine-stricken districts of the south. Maize is extensively cultivated and is eaten raw, or, in the form of meal, is used to make a kind of porridge or broth. In these latter forms it is one of the staple foods of the inhabitants. Wheat, millet, rice and earth-nut are cultivated, but not upon an extensive scale. Sesamé, particularly the black variety, is also grown, and an Indian trader has set up an oil press, worked by camels, to extract the oil from sesamé seed and cocoanut. Bananas, beans, peas, batatas and manioc are grown, especially manioc, of which the edible roots, being underground, are proof against the locusts, which periodically devastate the country

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Food crops predominate, but other crops, such as tobacco, are grown. Caoutchouc production makes slow progress; the planting of lianas, and sowing of seeds of the Ceara rubber plant have been made compulsory. Copra production has considerably increased owing to the fact that large cocoanut plantations have come under the control of owners who have checked the excessive waste of the palm trees involved in making native palm wine. In addition to cocoanut, a number of other palms are cultivated, including palmyra, doum palm, areca, phœnix, raphia, oil palm, and date palm. The natives have little knowledge of the value of these as sources of fibre. The local markets are well supplied with cassava, sweet potatoes, yam, pineapple, luffa, water melon, and other Cucurbitaceæ, papaw, mumune, aubergine, tomato, pepper, tamarind, bamia, jack fruit, onion, bean, pea, areca nut, earth nut, nutmeg, cashew, telfairia, plum, pomegranate, anona, guava, jambosa, lemon, lime, orange, mandarin and sugar-cane, all of these being grown in the Pangani district. In addition to its use in the manufacture of sugar the sugar-cane is of great importance to the inhabitants as a food. On the northern bank of the Pangani river about 1,000 acres are planted with sugar cane and a larger area adjoining is suitable for sugar planting. On the south bank of the river still more extensive areas are available. A local firm, known as the Pangani Company, has established a sugar factory, with all the necessary machinery, water supply, electric light, field tramway, laboratory and dwellings for German overseers. The factory began active work in 1902, and the first results have been promising as regards both sugar and rum. Near Mwera, in the Pangani district, the German East Africa Company has a fibre plantation containing 1,600,000 plants of sisal hemp, and it was expected that 350,000 lbs. of hemp would be exported at the end of the year, in addition to 145,000 lbs. which had been shipped to Hamburg early in the year. In the same district there is a plantation of 60,000 Liberian coffee trees. The Friedrich Hoffmann plantation has 150,000 Liberian coffee trees and 50,000 Arabian just coming into bearing. There are also about 70 acres of ramie, but here, as elsewhere, the development of a ramie industry is retarded by the want of a suitable decorticating machine. Vanilla is doing well. The estate has 15,000 Mauritius and sisal hemp plants. The German East Africa Company has another plantation in the same district at Lewa, and in it are cultivated 200,000 rubber trees (*Manihot Glaziovii*), and some Mauritius hemp. These are the principal crops, but coffee, cotton and local fruits are also grown in this plantation. Cattle and goats do not prosper here as the district suffers from Tsetse fly, but sheep do fairly well. The survey and mapping of the planting district has

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been completed. To facilitate communications an iron bridge is being built across the Pangani river.

In various parts of the Pangani district the local authorities are encouraging the natives to cultivate earth-nut, cocoanut, sesamé, sugar-cane, and rubber. Particular importance is attached to the cultivation of earth-nut for the sake of its oil. The production of sesamé is increasing as a result of distribution of seeds among the natives some years ago. Throughout the coast districts, and as far inland as Bondeiland, the cultivation of cocoanut palms has considerably increased of late, large quantities of seed-nuts having been distributed gratuitously by the Government and the communal authorities among the inhabitants. Raphia palm is very abundant, and efforts are being made to induce the natives to utilise its fibre. They are also encouraged to cultivate cotton, which is wild in the Pangani district. Its cultivation has been hitherto unknown to them. The destruction of rubber-yielding lianas is being checked by regulations. The district grows plenty of tobacco, and the quality has been improved by distribution of Sumatra seed. Johore trees, *Poinciara regia*, Melia, Casuarina, and teak have lately been planted. The Arab planters are heavily in debt to Indian traders, and to relieve them of the burden the Dar-es-Salaam Savings Bank has granted mortgage loans to the planters. Cattle brought from the interior high-lands quickly succumb to the diseases prevalent on the coast, but cattle born in the district do fairly well.

4. BAGAMOYO.

Bagamoyo has, in common with other towns in the north-eastern parts of the Colony, suffered loss as a consequence of the construction, in the adjoining British territory, of the Uganda railway, which has to some extent diverted from German East Africa to British East Africa the trade in goods coming from the interior and the great lakes. But with regard to agricultural production, the Bagamoyo district is doing well. Saadani exports a large proportion of its produce to Zanzibar, which is a centre of trade in produce from all the coast districts and many of the inland districts of German East Africa. In the coast lands near Bagamoyo the principal crops are manioc, rice, maize, matama, batatas, banana, chirokko, kunde, sesamé, and earth-nut. Further inland the principal crops are matama, millet, and maize, and in the fertile mountain regions rice, earth-nut, sesamé, batatas, banana, pine-apple, orange, mandarin and manioc. The Government lands of the district have been let to the Bagamoyo commune on a 50 years' lease. The commune employs a travelling inspector, who supervises native lands, encouraging extension of cultivation where this is desirable. Orange and mandarin plants have been obtained from the principal orange-growing countries. Experiments are being conducted in the cultivation of cotton, teak, eucalyptus, Ceara rubber, Mascarenhasia rubber, mango, oranges, *Cassia florida,* and Casuarina. The last-named appears likely to grow well in the coast-lands. As a result of assistance given by the commune to the natives, the extent of the cocoanut plantations on the coast has increased. Oil-cake obtained from local sesamé oil-mills is used as a fodder for cows. There are two vanilla plantations in the Bagamoyo district. The largest of these, the Kitopeni vanilla plantation, suffered somewhat during last year from excessive rain followed by drought, but nevertheless a moderate crop of vanilla was gathered. The other vanilla plantation belongs to a mission-station of the Vater vom Heiligen Geist fraternity established in Bagamoyo. These missionaries also cultivate oranges and mandarins. During the year they lost a hundred cattle, which were poisoned by eating a saline grass common in the neighbouring plains.

5. DAR-ES-SALAAM.

The town of Dar-es-Salaam is the seat of Government of German East Africa. The surrounding country is not so productive as it should be, and it is stated that there is much room for improvement, particularly as regards the cultivation of cocoanut, sesamé, earth-nut and rice, the produce of which crops might be exported. A large part of the traffic of Dar-es-Salaam is concerned with goods in transit from the interior for export to Zanzibar, South Africa and Europe. During the year large quantities of manioc were exported from Dar-es-Salaam to Zanzibar and Pemba. In the export of caoutchouc and copal, on the other hand, there was a decrease. There are no important European plantations. Attempts are being made to cultivate Indian and Egyptian cotton, and so far the crops are doing well. It has been found profitable to grow sesamé on sandy soil near the coast, while earth-nut did not prosper in that soil.

6. RUFIJI.

A good crop of rice was obtained during the year. Rice in husk is known as "punga," corresponding to the Indian "padi," while rice with the husk removed is called "mchele." It is stated that the rice grown in the district will not keep more than three or four months owing to the attacks of insects, whereas the rice imported to Dar-es-Salaam from India, which has perhaps undergone some process of preservation, keeps much longer. Matama yielded a good crop. The cocoanut plantations in the delta of the Rufiji river are increasing.

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Caoutchouc of good quality grows in the district, but no statistics of the trade were available. In some cases natives have been prosecuted for contravention of a law forbidding the making of fires in the caoutchouc-producing forests. Rice, matama and maize are the principal cereal crops. Other important crops in the coast districts are cocoanut, sesamé, Cucurbitacae, tobacco, and bananas. Sugar is grown, but not extensively. Locusts appeared early in the year and did some damage to various crops. In the Government plantations of the district are cultivated, but only on an experimental scale, jute, *Manihot Glaziovii* and *Cassia florida.*

7. KILWA.

Owing to drought last year the matama crop was very deficient, but there were fairly good crops of rice, maize and sesamé. Locusts have been troublesome during the past nine years, and during four years matama disease has been prevalent. The area under matama—formerly very large—has decreased. On the other hand, the oil-fruits—sesamé and earth-nut—are being cultivated more extensively. Hitherto, the produce of these has been exported to Zanzibar and Suez, where there are oil-mills. Instead of continuing to export to those places, the German East Africa Company is now sending trial shipments of sesamé, earth-nut and maize to Hamburg. Rice grown here is said to be equal in quality to the best Indian rice. It is hoped that enough will be grown locally to stop the importation of rice from India. The local authorities are encouraging cultivation of cotton by the natives, and have distributed a quantity of seed obtained from India and Egypt. Kilwa is noted for its caoutchouc, and the neighbouring plateau of Donde has the reputation of producing the best caoutchouc in German East Africa, but in recent years, owing to the wasteful methods of collectors, the yield has steadily decreased. In 1900 the Government established a caoutchouc plantation of 160 acres, and the plants are making good progress. During last year 20,000 Ceara rubber trees were planted. Some of the older ones are now 12 ft. in height. Unsuccessful attempts have been made to grow *Ficus elastica* and *Landolphia dondeensis.* On the plantations there is much difficulty in obtaining labour, owing to the fact that the natives go into the bush during a large portion of the year to collect rubber on their own account.

Mafia Island and the coast lands from the Rufiji to Kilwa grow immense numbers of cocoanut palms, and the value of their export of copra and cocoanuts in 1900 was 180,000 marks, and in 1901 300,000 marks. These districts produce more than half the total copra and cocoanut export of the whole colony.

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8. LINDI.

Lindi formerly received by caravan from the interior of the colony and from Portuguese East Africa considerable quantities of ivory, caoutchouc and tobacco for exportation. Ivory came from Songea and Nyassaland. The supply of these having decreased, the inhabitants have had to turn to other means of gaining a livelihood. Hitherto their principal food crops have been matama, maize and rice. Matama was grown very extensively, but in recent years locusts and "mafuta" disease have caused such severe losses that its cultivation may have to be abandoned. The maize crops have suffered less and the area under maize is increasing. The natives are advised by the authorities to grow more sesamé and earth-nut, as the oils yielded by these crops are always in demand. Lindi used to be regarded as the "granary of the colony," and large quantities of matama were sent from here to other places, particularly to the famine-stricken districts on the Rovuma river and elsewhere in the south. Lindi can now spare only small quantities, and the famine districts have had to obtain matama from the more distant towns, Pangani, Bagamoyo, and Kilwa. The Lindi-Hinterlandgesellschaft, whose headquarters are at Coblentz, in Germany, has near Lindi a fibre plantation containing 75,000 Mauritius hemp plants, 37,000 sisal hemp, 10,000 Yucatan sacci plants, 20,000 caoutchouc (*Manihot Glaziovii*), and some cocoanuts and cotton.

9. KILOSSA.

The crops were kept back last year by want of rain after seed-time, and were also injured by locusts. As famine is expected this year if the brood of locusts prove to be a large one, the inhabitants are cultivating plants whose edible portions are underground, viz.: Batatas, manioc, and earth-nuts. The principal crop of the district is matama. It was attacked by "mafuta" disease early in the year, but this was soon checked by heavy rains, and the yield was satisfactory. Maize is the next cereal in importance, and larger areas will be devoted to it if "mafuta" disease continues to destroy the matama. Manioc is abundant, although a few years ago the plant was almost unknown here. To encourage cultivation of this locust-resisting crop the authorities have accepted, in lieu of payment of taxes, 1,000 plants of manioc from a district in which they grow well, and have distributed them among the inhabitants of Kilossa. Last year a live-stock census was taken for the first time, and it was ascertained that the province has 17,000 goats, 5,000 sheep, 1,700 cattle, and 40 swine. The Kilossa authorities supply cattle to the military posts at Mpapua, Kondoa-Irangi, and Kilimatinde. The Kilossa country is mountainous, and teems with wild

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animals. Rewards were paid to hunters for killing, during the year, 11 lions and 122 leopards. Elephants are becoming scarce, but are still to be found in the Uluguru mountains.

10. Langenburg.

The remoteness of the situation of Langenburg, on Lake Nyassa, checks production by increasing the cost of transport. To reach the coast for exportation, produce has to cross Lake Nyassa by steamer and pass down the Shiré river to the mouth of the Zambesi. Rubber is no longer collected in large quantities, as the supply is becoming exhausted. The food-crops suffice for the needs of the inhabitants, who cultivate for their own use all the usual crops except matama, which is here scarce, owing to the prevalence of "mafuta" disease. Some maize is grown, but the natives live chiefly upon bananas and milk. Rice has hitherto come to Langenburg from the neighbouring British colonies, but the province is now producing enough for its own wants. It is hoped that rice, which thrives particularly well in Konde-land, will soon become an article of export. Crops of peas are a feature of the district, and potatoes and onions are sent across the Lake to British territory. A bamboo, said to be very useful for building, grows freely in Konde. A coffee estate, at 3,000 feet above sea level, has 30,000 coffee trees, and at higher altitudes there are several other coffee plantations. The brethren of a Herrnhuter mission station have succeeded in growing enough wheat for their own needs. Following their example the natives are starting wheat-fields. In the forests are some wild fruits, including a species of Anona, and trees locally named "msuku," "msunguli" (an oil fruit tree), and "mirale." Endeavours are being made to develope cattle breeding, as there is a great demand for cattle in British Central Africa and North-Eastern Rhodesia. Around Lake Rukwa the country is infested with Tsetse fly, but the rest of the Langenburg region has plenty of cattle, sheep and goats, the total number being estimated at 100,000.

11. Songea.

Ivory and caoutchouc have been the principal products hitherto, and of these large quantities were sent down Lake Nyassa, the Shiré, and the Zambesi, to the coast, or overland by caravan to Lindi, for exportation. The caoutchouc was obtained from a district north of Songea, situated at an altitude of 2,000 feet, but the sources of supply are becoming exhausted. 4,000 trees of *Manihot Glaziovii* (Ceara rubber) have lately been planted. Rice was introduced a few years ago by an Arab, and now grows well near the lake. The district is dependent for food on its own supplies, which are plentiful, the principal crops being maize, matama, sugar-cane, sweet potato and manioc. The mountainous parts are very fertile and yield

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vegetable products of great variety, owing to diversities of elevation and climate. Matama grows well in the sandy valleys with moist soils, and is the principal crop, maize and eleusine coming next. Eleusine is chiefly cultivated for the preparation of pombé (the native beer). "Mahalagwe," "baasi," and "ndosi" are local names of leguminous crops. Cotton and tobacco are grown, and a few mangoes and papaws. Cattle, sheep and goats were formerly very numerous in the grass lands, but in recent years disease and drought have destroyed many of them. Coffee was first planted four years ago, and the coffee leaf disease is at present unknown. It is believed that the laterite soil will prove favourable to coffee. 7,000 trees from Blantyre were planted last February. Endeavours are being made to grow Sumatra tobacco and *Acacia arabica.*

12. MAHENGE.

There are still fairly plentiful supplies here of caoutchouc and ivory, but conservation will soon become necessary. In the low-lands rice is cultivated, and in the hilly regions tobacco and matama. Among the mountains last year there was too much rain, and in the low-lands too little. Owing to frequent failure of the crops the natives live chiefly by collecting caoutchouc and hunting elephants. Cattle are scarce, although Mahenge has good grass-lands, good water, and not many wild animals, except in certain parts, where lions are numerous. There are no European plantations.

13. KISAKI.

Kisaki province has large areas of fertile land, particularly in the Uluguru mountains, to which the strong monsoon winds from the coast always bring plenty of rain. Dry winds from the direction of Victoria Nyanza blow across the great intervening plateaux. Plantations can only be formed in sheltered places among the mountains. Most of the produce in the hands of traders on the route from Kilossa to Dar-es-Salaam comes from Uluguru. Since the opening up of the Mahenge region there has been an increase of traffic through Kisaki, the demand for foods has risen, and the area under cultivation has been extended. The natives cultivate large quantities of matama, maize, manioc, potatoes, and Cucurbitaceae. Rice of good quality is grown in the low-lands, particularly in the fertile mountain valleys, and is conveyed by caravan to Dar-es-Salaam and Bagamoyo. It is asserted that the mafuta disease of matama occurs only when Cucurbitaceae are growing in the neighbourhood. A little tobacco is sent from Uluguru to the coast. In North Uluguru, at 3,000 feet above sea level, the "Emin" plantation has 150,000 trees of Arabian coffee, and another 150,000 are ready to be planted. Coffee-leaf disease has been checked by stripping the diseased trees, and by cutting trenches to aërate the soil, the earth from the trenches being spread upon the surface. Root disease of coffee is said to have been treated effectually by sprinkling at the roots of diseased trees a strong extract of the leaves of a so-called wild tomato. The owner of the plantation has reported, in addition to the above particulars, the discovery of a Garcinia yielding gutta, and of a gutta percha tree, in the forests.

14. IRINGA.

The crops cultivated by the natives are maize, various kinds of millet, tobacco, earth-nut, beans, manioc, and Cucurbitaceae, the chief food crops being maize, millet, and beans. There are three different types of country here. Westward extend the vast plateaux of the western half of the colony with their open undulating treeless grass-lands, southward are forest-clad mountain slopes, while here and there the land is agricultural and thickly populated. The number of cattle has decreased, many animals having been destroyed in the fighting which has frequently occurred between the Germans and the natives, who belong to some of the most savage of raiding and hunting tribes, accustomed to leave agricultural work to their women. The Utshungwe mountains are unfavourable for cattle, owing to excess of moisture and want of good pastures. A little to the west there are better pastures. Cotton is said to have been found wild in the forests near Madibira, and coffee near Mufindi. A plantation of 1,000 teak trees has lately been established. On the Ruaha river are numbers of wild animals, and elephants are abundant in the Utshungwe mountains. During the year 8 lions and 349 leopards were killed.

15. BISMARCKBURG.

The Ufipa plateau separates Lake Rukwa from Lake Tanganyika. Ufipa, Ukawendi, and Ukonongo are still rich in caoutchouc lianas, but the local trade is in the hands of Suahelis and Arab half-castes, who are agents sent by traders to buy caoutchouc from the natives. Elephants are becoming so scarce that the professional hunters have had to give up hunting as their main occupation. The animals come in March and June near to Bismarckburg from Ukawendi and Ukonongo, but few stay there throughout the year. In Ukonongo giraffes are plentiful. Near the Ugalla river and Lake Rukwa are immense herds of antelopes and zebras, and in Ufipa and Ukawendi are a few buffaloes and large numbers of lions, panthers, leopards, and hyænas.

16. UJIJI.

Rice is cultivated extensively in the lowlands by the lake and in the river-valleys, but the crop is often damaged by invasions of wild swine into the rice-fields. A considerable portion of the yield is sent to the Congo Free State. Wheat, of which good crops are obtained near Tabora, is grown only sparingly at Ujiji, although large areas are well adapted to it. The natives dislike wheat. They also, in many places, will not eat rice. Matama and manioc thrive well. The oil-palm is grown in Urundi. Salt of good quality is found in abundance, and the sources of supply have recently been declared crown land. Hitherto, it had been worked by the natives, who sold it, and with the proceeds bought food from Uha, and thus saved themselves the trouble of cultivating the land, which in future they will have to do. The southern part of Ukawendi was last year visited by swarms of locusts, which came from Ukonongo, but the country north of Ujiji was free from them. The Uha district has good cattle and large numbers of sheep and goats.

17. TABORA.

Where only five years ago there was nothing but bush and grassy plains in which Arabs and Wanyamwesi offered up sacrifices for rain, now rich cornfields extend as far as the eye can reach, the corps being matama, maize, and rice. Of matama the red as well as the white variety is cultivated, the red being used exclusively for brewing "pombé," and the white for making broth. A few fields have "mafuta" disease, but it is stated that in other fields the matama has appeared to be immune since the severe attack a year or two ago. Three kinds of maize, the red, the white, and the black, are grown, and all of these are used for making meal. Maize is also mixed with matama to make "pombé," and the natives prefer this to "pombé" made with maize alone. The drinking of this beverage is wide-spread among all the native races. Near Tabora there are excellent fields of rice. The rice is taken by caravan to Ujiji, Muansa, and Bukoba. Of the two kinds of rice grown here the white is preferred, on account of its size and flavour, to the red. Wheat cultivation near Tabora is carried on exclusively by Arabs. Enough is grown to supply the wants of the few European residents and the Arabs, and small quantities are sent to Ujiji and Muansa. Wheat bread is never absent from an Arab meal. Eleusine is grown only for making "pombé." Manioc, batatas, and earth-nut are extensively cultivated. The Arabs hold that there can never be a famine in Tabora, and a local Wanyamwesi proverb says, "Even though the locusts come there is still plenty to eat." Palm-oil comes into the market from Ujiji and Usumbura. Gourds are plentiful, and without them as water-vessels natives never start on a journey. Native cloths are made of locally grown cotton. The cultivation of hemp is forbidden, but it is cultivated nevertheless, and surreptitiously smoked by the drivers in their camps at night when on the march. Every place in the neighbourhood produces enough tobacco for its own requirements, and large quantities are sent to Kilimatinde, cattle being

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purchased in exchange. Bees are kept in every village, and the wax produced is of good quality. There are forests to the north and south of Tabora and on the Gombe river, the best building timbers being yielded by a *Pterocarpus sp*, locally known as "Mininga," and by a tree called "M'kola." The local names of other trees in the forests are "Myombo," "Mizima," "Misana," "Mivumba," and "Mirama." Tabora province has 120,000 sheep and goats and 45,000 cattle. The respect in which the native sultans are held depends upon the number of cattle they possess. These chiefs have now less power and fewer cattle than they had in former days. The Sultan of Ussongo is one of the largest cattle-owners, and that district and Msalala have large numbers of sheep and goats. Near Tabora, gold-reefs have recently been discovered.

18. MUANSA.

The principal crops are the red variety of matama and millet. The country is capable of producing more than it yields at present. Little agricultural produce is grown for sale to other districts. After harvest the supply of matama exceeds the demand, but at seed time demand exceeds supply, as the natives, instead of storing their surplus, convert it into "pombe." They will be able to grow produce on a larger scale for disposal elsewhere now that there is communication across the Lake and down the British railway to the coast. The rice grown here is inferior to that grown at Tabora. Sesamé and earth-nut have been little cultivated hitherto, as the natives had no seed, and there was no sale for the oils. These could now be grown and sent by the Uganda railway to the coast. The market in Muansa is generally well stocked with fish. Government timber reserves have been established in the islands at the southern end of the Lake, and the cutting of the trees known as mwule is prohibited. Near Muansa 2,000 oil-palms have lately been planted.

19. SHIRATI.

The natives are practically dependent for their food upon two crops, *Eleusine coracana* and millet. Of matama only the red variety is grown, and this on a small scale, this cereal having been introduced to the country for the first time only two years ago. Manioc was unknown till a year ago. South of Shirati the earth-nut is grown. The best land in the province is north of Shirati, close to the British frontier, and is at an elevation of 5,000 ft. There is also some good land, suitable for European settlement, between Shirati and Muansa.

20. BUKOBA.

Bananas are the favourite food of the natives and are very abundant. Eleusine and European beans are grown extensively, and wheat and maize are cultivated. The cultivation of potatoes has spread throughout the whole district, and potatoes can be ob-

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tained at any time of the year. The cultivation of rice is steadily increasing among the Arabs. Coffee has been found wild in the forests, and coffee plantations are being established. The first attempts to grow locally the "Msiku" tree on a large scale failed, but the experiments are being repeated. Bukoba has more animals than any other province in the Colony, the estimated numbers being 1.500,000 sheep and goats and 50,000 cattle.

A NEW SOURCE OF COPAL RESIN.

There is a continuous demand in commerce for hard resins of the types known as copal, dammar and kauri, which when dissolved in drying oils produce varnishes distinguished by leaving, when applied to wood, paper, and similar surfaces, a hard, lustrous, transparent coat. Such properties in resins appear to be associated with the presence of non-crystalline constituents, and for this reason the common resins, such as those produced by the various species of *Pinus*, which contain the comparatively simple, crystalline acids—abietic and pimaric—are less valued. As the sources of such valuable resins at present known are comparatively limited in distribution it is a matter of great interest to be able to record the discovery of a new copal-yielding species. Messrs. Heckel and Schlagdenhauffen describe in a recent number of *La Revue des Cultures Coloniales* (1903, xii. 351), the fruits of the tree *Dipteryx ordorata* and the copal resin obtained from them. This tree, which yields the well-known "tonquin beans," contains in the leaves, stem and fruits a large number of special cells in which the resin is secreted. The fruits contain on the average about 16 per cent. of this material. The chemistry of resins is as yet not sufficiently advanced to admit of ready identification of new products of this kind, but the properties of the resin of *Dipteryx ordorata*, in particular its solubilities in various liquids, its melting point, and its colour reactions with mineral acids are in good agreement with those given by Manilla copal. This preliminary work is regarded by the authors as sufficiently promising to warrant their inaugurating in the French Colony a series of incision experiments with the stems of well-developed trees in the hope of obtaining a commercial supply of the resin.

IMPERIAL INSTITUTE BULLETIN,

1903, No. 4.

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THE IMPERIAL INSTITUTE.

The Imperial Institute was founded as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May, 1893. The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of India and the Colonies, and providing for the collection and dissemination of scientific, technical and commercial information relating to them. Until the end of 1902, the Imperial Institute was managed by a Governing Body, of which the Prince of Wales was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900, the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned to the use of the University of London. In July, 1902, an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of India and the Colonies, as well as of the India and Colonial Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1st, 1903.

In accordance with the above Act, the Imperial Institute is now managed by the Board of Trade in consultation with the Advisory Committee, through their Commercial, Labour, and Statistical Department, of which Mr. H. Llewellyn Smith, C.B., is Comptroller-General.

The Board of Trade have appointed Professor Wyndham Dunstan, F.R.S., hitherto Director of the Scientific and Technical Department, to be Director of the Imperial Institute at South Kensington, with charge of the various branches of work there carried on.

The work hitherto carried on by the Imperial Institute at South Kensington and in the City for the supply of general commercial, statistical and tariff intelligence is now conducted by the Commercial Intelligence Branch of the Board of Trade, which, subject to the Comptroller-General, is under the direction of Mr. Thomas Worthington. (See statement as to the work of the Commercial Intelligence Branch published in the "Board of Trade Journal.")

The principal entrance of the Imperial Institute is at the West (Queen's Gate) end of Imperial Institute Road, South Kensington. This gives access to the principal floor, containing the general enquiry office, library, reading rooms, colonial conference rooms, and the library and reading room of the Northbrook Society.

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The first floor contains the General offices, the Reference Sample Room of the Scientific and Technical Department, the offices of the British Women's Emigration Association, and of the Colonial Nursing Association.

The second floor is entirely devoted to the laboratories of the Scientific and Technical Department.

The public entrances to the Indian and Colonial collections are at the East (Prince's Gate) end and the West (Queen's Gate) end of the Imperial Institute Road.

The Imperial Institute works in co-operation with the Commercial Intelligence Branch of the Board of Trade at Whitehall, with an enquiry office in the City (49, Eastcheap, E.C.) under the management of this Branch, and with the Emigrants' Information Office in Westminster.

Indian and Colonial Economic Collections.—The Collections of economic products illustrative of the commercial resources of India and the Colonies are arranged on a geographical system in the galleries of the Institute. Mr. W. G. Freeman, A.R.C.S., B.Sc. (Lond.), F.L.S., lately of the Imperial Department of Agriculture for the West Indies, has been appointed Superintendent of the Colonial Collections.

Special Curators are appointed by the Governments of India, Ceylon, Canada, and the Cape; whilst the operations of the Indian Section are supervised by a committee appointed by the India Office.

The Collections are open free to the public daily, except on Sundays, from 11 a.m. till dusk.

It is intended, in consultation with the Governments concerned, to re-arrange and make extensive additions to many of these collections, and this work is in progress.

The following British Colonies and Dependencies are represented by collections of their products:—

British Africa.

Cape Colony.
Natal.
Rhodesia.
British Central Africa.
East and West African Settlements.
Mauritius.
Seychelles.

British Australasia.

New South Wales.
Victoria.
South Australia.
Western Australia.
Queensland.
Tasmania.
New Zealand.
Fiji.

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BRITISH AMERICA.

Dominion of Canada.
Newfoundland.
Bermuda.
Bahamas.
Jamaica.
Barbados.
The Leeward Islands.
The Windward Islands.
Trinidad and Tobago.
British Guiana.
British Honduras.

BRITISH INDIA AND THE EAST.

India.
Ceylon.
Straits Settlements and Federated Malay States.
Hong Kong.
British North Borneo.

OTHER BRITISH POSSESSIONS.

Malta.
Falkland Islands.

Information concerning India and the Colonies, their commercial products, industries, trade, prospects for emigration, &c., may be obtained on application to the Curators for India and Ceylon, Canada and Cape Colony, at their offices in the Sections, at the Central Stand in the Galleries, at the General Enquiry Office, or enquiries may be addressed in writing to the Director of the Imperial Institute, South Kensington, S.W.

The Scientific and Technical Department.—The laboratories of this Department, which occupy the second floor of the Imperial Institute, were established chiefly with the aid of grants from the Royal Commission of the 1851 Exhibition, in order to provide for the investigation of new or little-known products of India and the Colonies and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the trade and industries of India and the Colonies.

The work of the Department is chiefly initiated by Departments of the Governments of India and the Colonies. Arrangements have been also made by the Foreign Office, whereby British Consuls may transmit to the Department for investigation, such natural products of the countries in which they are appointed to reside as are likely to be of use to British manufacturers and merchants.

Materials are first chemically investigated in the laboratories of the Department, which has a staff of skilled assistants, and are afterwards submitted to technical trials by experts attached to the Department and finally are commercially valued.

Except under special circumstances the Department does not undertake investigations for private individuals.

A few illustrations of the work of the Department may be given here.

(*a*) The examination, in the Department, of Indian plants likely to be suitable as vegetable tanning agents, pointed to the conclusion that several would probably be useful to European

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tanners. One of these (*Cæsalpinia digyna*) was submitted to complete chemical investigation with very promising results. Tanning trials were next made on the large scale by one of the tanning experts attached to this Department, whose results confirmed the conclusion that a valuable tanning agent had been found. On the publication of the report on the subject, which was widely noticed in technical journals, a demand almost at once arose for the material in England, on the Continent, and in America, and the authorities in India are now arranging for the commercial supply.

(*b*) A plant abundant in India (*Podophyllum Emodi*) was found on chemical investigation in the Department to furnish the same constituents as the well-known drug of American origin, *Podophyllum peltatum.* The co-operation of physicians at St. Thomas's Hospital was secured, and preparations of the plant were extensively tried as a drug and found to be as valuable as those made from the American plant. A considerable demand now exists for the plant, which has been officially recognised by the Indian Medical Department, and arrangements are being made in India for a regular commercial supply.

(*c*) The same practical result has followed from the chemical investigation of a plant abundant in the Egyptian desert (*Hyoscyamus muticus*) for which a commercial demand as a drug has also arisen.

(*d*) The quality of the entire series of Indian coals has been experimentally ascertained. These represented the principal coal-seams of India, and the report has been in large request both in this country and in India. It has now been issued as an official paper by the India Office.

(*e*) The cause of the poisonous effects produced, at certain stages of their growth, on horses and cattle by certain food grains and fodder plants of India and the Colonies has been investigated, and the nature of the poison and the conditions of its occurrence determined.

(*f*) The chemical composition of india-rubber of various kinds derived from the Colonies which do not at present share in this trade, has been determined experimentally, and on the basis of these results commercial valuations have been obtained, and in some instances sales of consignments of the material have been effected.

(*g*) Collections of minerals from British Central Africa, from Somaliland, and from Northern and Southern Nigeria have been chemically examined. In certain cases where it seemed desirable, minerals have been subjected to technical trial on the large scale by manufacturers, and commercial quotations for the products

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obtained. Arrangements have also been made, through this Department, for the working of mineral deposits in the Colonies by English firms.

(*h*) The quality of leather tanned in several of the Colonies has been experimentally investigated, and with the aid of experts its suitability for the English market has been ascertained and suggestions made for its improvement.

(*i*) The chemical composition of certain oil-yielding nuts sent by British Consuls in Brazil and Portuguese South Africa, and from British Honduras and the Straits Settlements, has been investigated and their properties brought under the notice of British manufacturers and brokers. In several cases arrangements are being made for consignments of the products to be sent to this country.

(*j*) Scientific and technical information has been supplied as to the curing of tobacco (Bermuda, British Central Africa, Rhodesia, and Assam), the working of mica deposits (Somaliland and Southern Nigeria), the suitability of iron ores for smelting (India), the production of wood-pulp (Natal), the cultivation of Indian hemp, and many similar subjects. It will be seen that the results of the work of the Department are often of as much importance to British manufacturers as to the trade of the Colonies concerned. A large room on the first floor, which formerly contained the library, is now occupied by a reference collection of samples of economic products, derived chiefly from India and the Colonies, which have been investigated and reported on by the Scientific and Technical Department, and as to which full information is available.

The principal Technical Reports and Scientific Papers which have emanated from this Department since it was fully established in 1896 have now been published in a single volume, which may be purchased at the Central Stand (price 15*s*.).

Library and Reading Rooms.—The library and reading rooms of the Imperial Institute have been entirely re-arranged during the present year. They contain a large collection of Indian and Colonial works of reference, and are regularly supplied with a number of the principal official publications of India and the Colonies, and with many of the principal newspapers and periodicals of the United Kingdom, India, and the Colonies. The library also includes a number of Indian and Colonial maps and charts.

The library and reading rooms are on the principal floor, and are entered through the main entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of persons introduced by them. Adjoining is the library and reading room of the Northbrook Society.

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Colonial Conference Rooms.—Three large rooms, specially decorated and furnished, are reserved on the principal floor for use by the representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The rooms in connection with this Hall are in the occupation of the Indian Committee of the Imperial Institute, whilst the Imperial Institute, the India Office and the London University have the right of using the Hall for lectures, meetings, &c.

Unofficial Societies occupying rooms in the Imperial Institute:—

(*a*) **The Northbrook Society.**—This Society, founded by the Earl of Northbrook, has a Library and Reading Room, which has been transferred to the principal floor of the Imperial Institute, and is available for the use of its members, who have also the privilege of using the adjoining Library and Reading Rooms of the Imperial Institute. The membership of this Society is open to natives of India and to persons officially connected with, or interested in, the Indian Empire. Communications should be addressed to the Secretary, Northbrook Society, Imperial Institute, S.W.

(*b*) **British Women's Emigration Association.**—The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and the prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

(*c*) **Colonial Nursing Association.**—This Association has been assigned an office on the first floor of the Imperial Institute (Room 5). Its principal object is the selection of trained hospital and private nurses for the Crown Colonies and other British Dependencies.

LIBRARY.—RECENT ADDITIONS.

Books and Publications, exclusive of Government Publications, presented by Publishers to the Library of the Imperial Institute since October, 1903.

Australasia.—The Commonwealth and New Zealand	By Arthur W. Jose.
Natal and the Boers.—The Birth of a Colony	By T. Rowell.

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The Civilisation of India	By R. C. Dutt, C.I.E.
The Coming of the Colonist	By C. D. Brownfield.
A History of South Africa	By W. Basil Worsfold.
	(*Messrs. J. M. Dent & Co.*).
Agriculture for Beginners	By C. W. Burkett, F. L. Stevens, and D. H. Hill.
General History of Commerce	By W. C. Webster, Ph.D.
A First Book of Forestry	By F. Roth.
	(*Messrs. Ginn & Co.*).
Self Government in Canada and how it was achieved	By F. Bradshaw.
Cape Colony for the Settler	By A. R. E. Burton.
	(*Messrs. P. S. King & Son*).
Animal and Vegetable Oils, Fats and Waxes, and their manufactured products	By the late C. R. Alder Wright, F.R.S., and C. A. Mitchell, F.I.C.
Foods.—Their Composition and Analysis	By A. W. Blyth, F.I.C., and W. W. Blyth, F.I.C.
Water Supply	By R. E. Middleton, M. Inst. C.E.
Prospecting for Minerals	By C. Herbert Cox.
	(*Messrs. C. Griffin & Co.*).
The Soil	By A. D. Hall.
In the Andamans and Nicobars	By C. Boden Kloss.
	(*Mr. John Murray*).
The Microscopical examination of Foods and Drugs	By H. G. Greenish.
	(*Messrs. J. & A. Churchill*).
Impressions of Indian Travel	By Oscar Browning.
	(*Messrs. Hodder & Stoughton*).
Canada	By K. Baedeker.
Egypt	By K. Baedeker.
London	By K. Baedeker.
	(*Messrs. Dulau & Co.*).
Agricultural Geology	By J. E. Marr.
	(*Messrs. Methuen & Co.*).

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INDIAN AND COLONIAL COLLECTIONS.

NOTES ON RECENT ADDITIONS.

Central Stand for Publications and Enquiries.—A stand has been opened in the centre of the main gallery to facilitate the answering of enquiries and the distribution of literature. Pamphlets, circulars, handbooks, &c., containing information relating to the commerce, agriculture, mining and other industries of the principal British Colonies, and also to emigration, may be obtained gratuitously. Certain publications are for sale. (See lists on cover.) The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. The principal Indian and Colonial newspapers may be seen on application.

An officer of the Institute is in attendance at this stand, which is in telephonic communication with the offices of the Curators and with the General offices in the main building.

India.—A large number of the exhibits in this section have been re-arranged. Preliminary lists of "edible substances," "oil-seeds and oils," "gums and resins," and "dyes and tans," have already been printed, and copies can be obtained gratis on application to the Curator of the Indian section, or at the Central stand.

An interesting collection of textile fabrics illustrating the use of wax, either for ornamental printing in relief on a coloured ground, or as a resist for protecting certain portions of a design from the action of dyes, has been arranged in the Indian section. An extensive collection of samples of textile fabrics, including tweeds, serges, drills, twills, sheeting, towelling, &c., contributed by Bombay and Madras manufacturers has now been arranged in the East Gallery.

Canada.—A comprehensive collection illustrative of the economic minerals of British Columbia, and also an exhibit of furniture and carriages entirely manufactured in Canada of Canadian woods are being shown in the western end of the North Gallery. A new collection of specimens illustrating the cereal resources of British Columbia has been added to the Canadian section.

Straits Settlements and Federated Malay States.—Considerable progress has been made in the re-organisation of this Court, on a plan prepared last year by Professor Dunstan, which was approved by the Government of the Straits Settlements, by whom the work of collecting and preparing in the Colony the new exhibits required was entrusted to Mr. H. N. Ridley, M.A., Director of Botanic Gardens and Forests at Singapore. Much assistance has kindly been given by Mr. Leonard Wray, F.Z.S., Curator of the Government Museum at Perak, whilst on leave in this country.

The Straits Court is being re-modelled in accordance with the general scheme for the improvement of the Collections, the object in view being to render the exhibits of greater value to commercial

Notes on Recent Additions.

men, for educational purposes, and as a means of bringing to public notice recent developments in economic research. To this end the specimens have been thoroughly overhauled and a representative series selected for exhibition. Temporary labels have been added giving information describing the collection and manufacture of important products, and the local uses of other products, many of which do not appear as exports. These temporary labels are being replaced as rapidly as possible by fuller, specially prepared, printed labels, and when this work is completed it will be possible for the visitor to learn, as completely as the specimens allow, the method of cultivation, collection and manufacture of the products, and the uses to which they are put.

The tin industry has received special treatment in view of its paramount importance, and a complete series of specimens and photographs, illustrating the modes of occurrence of the tin ores, the methods of mining and smelting, have been placed on exhibition with full descriptive labels.

The geology of the peninsula is illustrated by a set of specimens with notes on the occurrence, geological age, and economic importance of the several formations.

Rice, sago, sugar, rattan canes, gutta-percha, rubbers, dammar resins, fibres, gambier and other tanning materials, dye stuffs, spices, &c., are similarly represented by selected specimens and descriptions of their collection, manufacture and uses.

Statistical tables showing the area, population, revenue, expenditure, trade and exports, prepared by the local Government, have been placed in the Court.

An important addition is a large map specially prepared for the Court, showing the several Settlements and States under British administration, the railways, and other features of interest.

When the new exhibits arrive and have been incorporated in the present collection the Court will give a full and accurate representation of the economic resources of the Straits Settlements and Federated Malay States, and prove an important factor in extending public knowledge of the country and furthering its commercial interests.

British North Borneo.—A collection of the commercial products of British North Borneo, including timbers, coal, rice, sago, sugar, coffee, cacao, pepper, tobacco and cigars, camphor, gutta-percha, dammars, cutch and gambier, is on view in the North Gallery.

Western Australia.—Furniture manufactured from the principal hardwoods of the State, chiefly Jarrah and Karri, illustrating the adaptability of these woods for mouldings and turned work, as well as their susceptibility of taking a high polish and finish, is shown in the North Gallery.

Queensland.—A collection of the more important products of Queensland, especially minerals, and a large number of photographs is shown in the North Gallery.

NOTES ON THE COLLECTION OF RATTANS IN THE STRAITS SETTLEMENTS' COURT.

Rattan canes, one of the most important products of the Malay Peninsula, are the stems of climbing palms belonging to several genera of the palm order (*Palmeæ*), some of the best known canes or rattans being those of *Calamus*, *Dæmonorops*, *Korthalsia*, and *Plectocomia*. In the jungle these palms climb to the tops of high trees by the aid of stout re-curved thorns on the backs of their feather-shaped leaves or on special long flagellæ, and often form very dense thickets. The Malays and Sakais, in collecting rattans, select the best, cut them through at the base with a "parang" or chopping knife, and disentangle and pull them down from the trees. The upper portion of the stem, bearing leaves and a thick thorny bark, is of little use, and is cut off and rejected. The canes are coiled up for convenience of carriage from the jungle to the factory, where they are cleaned by being washed and rubbed with sand, straightened and cut into lengths.

Their chief local use is in house-building, but they are also used to make baskets, chairs, tables, matting, fish-traps, cables, bridges, or as tying material. The thick canes of good appearance make walking sticks, and those which are too rough for this purpose are used for the internal framework of chairs and tables. "Crushed cane," which is used in Europe to stuff cushions, consists of small pieces of waste rattan. Rattan canes are also exported and made up into furniture in Europe and America.

Twenty-six distinct varieties are exhibited in the Court, accompanied by information as to their uses, and their Malay and scientific names. Local names in most cases express some characteristic by which a rattan is distinguished from its neighbours in the jungle. The "Branched Rattan," *Rotan Dahan* (*Plectocomia elongata*, Mart. and Blume), is a branching high-climbing plant, and one of the thickest rattans of the Malay Peninsula, where it is very abundant. It often attains a length of 150 ft. Owing to its rough appearance it is used only for the internal framework of chairs and to make mining baskets, &c. The "Solitary Rattan," *Rotan Tunggul* (*Plectocomia geminiflora*, H. Wendl.), is a much more slender rattan, scarcely exceeding $\frac{1}{5}$ to $\frac{1}{4}$ inch in diameter, although it may be 100 feet in length. This is the best of all the rattans, fetches the highest price, and is used particularly in making baskets and furniture. The "Ant Rattan," *Rotan Semut* (*Korthalsia scaphigera*, Mart.), is often infested by ants, which live in the swollen bases of the leaf stalks. It is used for basket work and also as a tying material. The "Joint Rattan" or "Wax Rattan," *Rotan Sindi* or *Rotan Lilin* (*Calamus javensis*, Bl.), is a very slender rattan, about $\frac{1}{6}$ inch diameter and 20 to 30 feet in

Notes on the Collection of Rattans in the Straits Settlements Court.

length. Being smooth and white and having inconspicuous joints, it is very suitable for basket work. The "Stone Rattan," *Rotan Batu* (*Calamus insignis*, Griff.), which has a stem scarcely more than $\frac{1}{3}$ inch in diameter, and 50 to 60 feet in length, occurs in all parts of the Peninsula, and is used for fishing stakes and other purposes. *Rotan Sega* (*Calamus caesius*, Bl.) is one of the more important rattans used in making chairs, tables, baskets, &c. Before the introduction of matches, fire was kindled by rapid friction of strips of this rattan round a piece of dry wood. The "Dragon's Blood Rattans," *Rotan Jerenang* (*Daemonorops Draco* Blume, and *D. propinquans*, Becc.), bear fruits which yield the red dye known as Dragon's Blood. *Rotan Kerai* or *Rotan Gulang* (*Daemonorops geniculatus*, Mart.) is a very long rattan, about $\frac{1}{2}$ inch in diameter. *Rotan Serian* is used in weaving the partition walls of houses. A bundle of split rattan of this kind, as sold in the native shops, is exhibited in the Court. A rope of Twisted Rattan (un-named) is also exhibited, and consists of strips of split rattan, beaten while still fresh to render them pliable, and then twisted into ropes. These ropes are very strong and durable, and are extensively used as cordage, &c., in the Peninsula.

A number of specimens of rattan work have recently been added to the Court, including trays, office-baskets, wine-baskets, clothes-baskets, and other small articles of basketwork, as well as larger articles, such as a lounge and an upright chair. The diversity of uses to which rattans can be put is further illustrated by a marine "fender" of the type commonly used to prevent injury of a ship against a wharf. The specimens exhibited bear a label stating their present cost price at Singapore.

A series of photographs, illustrating the rattan industry, have also been received from the Director of Botanic Gardens at Singapore. They illustrate the processes of soaking the rattans in a tank, to soften them before they are straightened; the straightening of the rattans, by working them backwards and forwards round a post; the rattan factory, with its drying ground, and the sheds in which straightening and sorting take place; and, finally, the making-up of the cleaned canes into bundles, ready for exportation.

Bulletin of the Imperial Institute.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

MINERAL SURVEY OF SOUTHERN NIGERIA.

At the instance of the Government of Southern Nigeria, a Mineral Survey of that Colony is to be conducted under the direction of the Imperial Institute, in the first place for a period of three years.

Mr. John Parkinson, M.A. (Cantab.), F.G.S., who has been appointed Principal of the Survey, and Mr. L. H. Huddart, B.A. (Cantab.), A.R.S.M., the second officer, are now on their way to Southern Nigeria, with instructions to explore given localities for minerals of economic importance.

The minerals systematically collected in Southern Nigeria are to be forwarded to the Imperial Institute for chemical examination and assay in the laboratories of the Scientific and Technical Department. Their probable uses having been indicated by the results thus obtained, the materials will be submitted for trial on a larger scale by manufacturers and other experts attached to the Department, in order that their precise technical and commercial value may be ascertained.

Explorations are at first to be restricted to deposits of those minerals such as limestone, iron ores, tin and other metallic ores which are of commercial importance, so that the economic mineral resources, at any rate, shall be generally ascertained, and the way thus paved for their commercial development.

The mineral deposits of Southern Nigeria are virtually unknown, but the preliminary examination in the Scientific and Technical Department of the Imperial Institute, of a few specimens sent from this country, renders it evident that they may prove to be of considerable value.

Since, owing to the rainy season, the actual work of exploration in Southern Nigeria can only be conducted during eight months of the year, both of the officers will return to England after the expiration of that period, and will take part at the Imperial Institute in the examination of the numerous minerals which will have been collected. A report on the results of the survey will eventually be published.

The Imperial Institute has been engaged during the past year in examining a number of mineral specimens collected in Northern Nigeria at the instance of the High Commissioner, Sir F. Lugard. These include several substances likely to be of commercial importance, including a remarkably rich ore of tin, which is stated to occur in considerable quantity, of which an account has been already given in the Imperial Institute Bulletin, Vol. I., page 21.

I.—REPORTS ON RECENT INVESTIGATIONS.

The following notices have been selected from reports recently made by the Scientific and Technical Department:—

THE COMMERCIAL UTILISATION OF THE SEEDS OF THE PARA RUBBER TREE (*HEVEA BRASILIENSIS*).

A considerable amount of activity has been displayed within the last few years in tropical countries in the cultivation of various kinds of rubber trees in order to meet the growing demand for rubber in the arts. In the Federated Malay States large areas have thus been planted with the Para rubber tree (*Hevea brasiliensis*), and it has become necessary to find a method of utilising the large quantities of seeds now produced in these plantations. Several consignments of these seeds and of meal prepared from them have been received recently at the Imperial Institute from the Assistant Superintendent of Forests and Gardens, Penang, and from the Curator of the Perak Museum, with the request that they should be examined and their commercial values ascertained.

These samples have been submitted to chemical examination in the Scientific and Technical Department of the Imperial Institute with the following results:—

Chemical Examination of Seeds.

The kernels constitute about 50 per cent. by weight of the whole seeds. On extraction with light petroleum they yielded 42·3 per cent. of oil (specimen A), whilst the whole seed (husk and kernel ground together) furnished 20 per cent. of oil (specimen B).

The oil obtained from the kernels alone is clear, of a light yellow colour, and has an odour somewhat resembling that of linseed oil. It belongs to the class of drying oils, and yields a clear, transparent film, when allowed to dry by exposure to air. The husks contain a solid fat which has a high saponification number and a low iodine value, but since the amount of this solid fat in the husks is very small it makes but little difference to the properties of the oil obtained from kernel and husks ground together. The following table gives the constants found for both specimens of the oil, those of linseed oil being added for comparison:—

The Commercial Utilisation of the Seeds of the Para Rubber Tree (Hevea brasiliensis).

—	Para Rubber Seed Oil. A. (from kernels only).	Para Rubber Seed Oil. B. (from whole seed).	Linseed Oil.
Specific gravity at 15° C.	0·9302	0·9316	0·931—0·937
Free fatty acids—			
Acid value	10·7	19·0	0·8—8·9
Calculated as oleic acid ...	5·4 %	9·6 %	0·4—5·7 %
Ester value	195·4	190·3	—
Neutral oil	94·6 %	90·4 %	95·5—99·6 %
Saponification value	206·1	209·3	187—195
Iodine value...	128·3	121·2	160—181

On saponification with caustic soda, Para rubber seed oil yields a rather soft soap of yellowish colour. It was found that the time required for the complete saponification of this oil is about half as much again as that required in the case of olive oil.

Para Rubber Seed Meal.

The sample consisted of about seven pounds of finely ground meal of a pale buff colour; it was free from husk, and possessed the pleasant odour characteristic of oil meals.

Extraction and Examination of the Oil contained in the Meal.

On extraction with light petroleum, the meal yielded 36·1 per cent. of an oil which had a slightly acid odour and, on standing, solidified as a soft, crystalline, yellow mass. It furnished the following constants:—

Specific gravity at 15° C. ...		0·911	
Free fatty acids	Acid value	130·5	
	Free acids (calculated as oleic acid)	65·6	per cent.
Neutral oil		34·4	„
Ester value		65·2	
Saponification value		195·7	
Iodine value		136·2	

When heated, the oil began to melt at 19° C., and was a clear liquid at 28° C. It had very marked drying properties, and yielded a solid, transparent film. On saponification with caustic soda, the oil furnished a rather soft soap of a yellowish colour.

In the following table, the constants and properties of the oil extracted from this sample of meal are contrasted with those

The Commercial Utilisation of the Seeds of the Para Rubber Tree (Hevea brasiliensis).

of the oil obtained from the freshly crushed decorticated seeds; the constants of linseed oil are again added for comparison.

—	Oil extracted from Para Rubber Seed Meal.	Oil extracted from decorticated Para Rubber Seeds (freshly crushed).	Linseed Oil.
Yield of oil per cent....	36·1	42·3	33 - 37
Physical state..	Solid below 19° C.	Liquid at 15°	Liquid at 15°
Specific gravity 15°/15°	0·911	0·9302	0·931—0·937
Free fatty acids per cent. (calculated as oleic acid)...	65·6	5·4	0·4—5·7
Iodine value	136·2	128·3	160—181

It will be observed that the oil extracted from the meal was solid, whereas that obtained from the freshly ground seed was a liquid. This difference is due to the large proportion (65·6 per cent.) of free fatty acids present in the former, whilst the latter contained only 5·4 per cent. of free acids. The cause of this difference in the two oils has been investigated, and it has been found that after the seed has been crushed the oil gradually undergoes decomposition, owing to the action of a hydrolytic enzyme contained in the seed, which will be made the subject of special study.

Analysis of the Meal.

The meal furnished the following results on analysis:—

Moisture	9·1 per cent.
Ash	3·53 „
Fibre	3·4 „
Oil	36·1 „
Proteids	18·2 „
Carbohydrates	29·67 „

The ash was found to contain 30·3 per cent. of phosphoric acid (calculated as P_2O_5) present in the form of phosphates, which is equivalent to 1·07 per cent. of phosphoric acid in the meal.

The results of this examination of the Para rubber seed meal indicate that the material thus prepared could neither be used as a fodder, owing to the presence in it of large quantities of free fatty acids, nor for the expression of Para rubber seed oil since the latter has been largely decomposed. It is probable, however, that if the oil were expressed from the decorticated seeds, the residual cake could be utilised as a feeding material, as is shown by the following comparison between the calculated

The Commercial Utilisation of the Seeds of the Para Rubber Tree (Hevea brasiliensis).

composition of such a cake and the compositions of some commercial feeding cakes:—

	Moisture, per cent.	Ash, per cent.	Proteids, per cent.	Fibre, per cent.	Fat, per cent.	Carbohydrates, per cent.	Nutrient Value.
Calculated composition of—							
Para rubber (seed cake) ...	13·36	5·19	26·81	5·00	6·00	43·64	84·25
Linseed cake (new process) ...	9·4	5·4	35·6	7·1	7·5	35·0	87·85
" " (old process) ...	10·8	5·0	28·6	6·7	10·6	38·3	91·28
Cottonseed cake (new process)	11·12	6·10	38·47	9·78	8·78	25·75	84·4

These figures show that a cake prepared from Para rubber seed meal would compare favourably with other cakes as a cattle food, and that it contains a particularly low proportion of indigestible matter (fibre).

Commercial Valuation.

Specimens of both the seeds and oil have been submitted to leading brokers. They report that the oil could probably be used as a substitute for linseed oil and would be worth at present about 20*l*. per ton, but that oil merchants would not take it up unless they first had an opportunity of testing it in bulk. The brokers consider that it would be more profitable to ship the seeds themselves to this country, as is done in the case of most other oil seeds. They value the decorticated seeds at 10*l*. to 12*l*. per ton, and add that they would be prepared to take two or three tons at the lower price in order to introduce them into the market.

The Para rubber seed meal was not commercially valued, since in its present condition it could not be utilised in any way. Para rubber seed "cake" of the composition already given should be almost as valuable as linseed cake, which at present sells at from 5*l*. 15*s*. to 6*l*. 15*s*. per ton.

The results of this investigation lead to the conclusion that the seed of the Para rubber tree is a valuable economic product, and is likely to become of considerable commercial importance. The oil could probably be employed for the purposes to which linseed oil is applied, whilst the residual cake would be of value as a cattle food. The oil should be expressed from the kernels before these have been ground, and for this reason the seeds should, if possible, be decorticated and the kernels exported unground.

THE EXPERIMENTAL CULTIVATION OF CASTILLOA AND FUNTUMIA RUBBERS IN TRINIDAD.

The samples of rubber were prepared in connection with the experimental cultivation of various rubber-yielding trees in Trinidad, and were forwarded to the Scientific and Technical Department of the Imperial Institute chiefly with the object of ascertaining by chemical investigation, supplemented by commercial valuation, the influence of the age of the tree on the quality of the rubber it furnishes, and also by the same means to determine the effect of the method of coagulation employed on the quality of the rubber furnished by the latex.

I.—Two Samples of Castilloa Rubber.

Two small samples of rubber, prepared respectively from old and young trees of *Castilloa elastica,* were forwarded to the Imperial Institute for comparative chemical examination by the Superintendent of the Royal Botanic Gardens, Trinidad. In the accompanying letter, Mr. Hart stated that the rubber had been prepared from the latex by creaming and draining, and pointed out that in physical properties the rubber derived from young trees was much inferior to that yielded by the older trees of the same species.

(1.) Rubber from young trees (4 years old).

The specimen showed very little resemblance to true rubber, and was evidently highly resinous. It was almost black, rather hard in the lump, but could be moulded by pressure, and was easily indented with the finger nail; small fragments were soft and sticky. It exhibited very little tenacity and no elasticity.

(2.) Rubber from old trees.

This was a specimen of good rubber, almost black, only slightly sticky, very elastic and exhibiting considerable tenacity.

A chemical examination of each of the two specimens gave the following results:—

—	Moisture.	Caoutchouc.	Resin.	Dirt.	Ash included in Dirt.
Rubber from young trees (4 years old)	0·54	33·6	64·1	1·7	0·35
Rubber from old trees ...	0·41	81·9	15·8	1 9	0·34

The purified caoutchouc from the rubber of the young trees

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

was very soft and sticky, whereas that furnished by the rubber from the older trees exhibited very satisfactory physical properties.

These analyses amply confirm the opinion based upon the appearance of the samples, and prove that the rubber prepared from the latex of the young trees of *Castilloa elastica* is a very inferior product, consisting largely of resin. The results agree with previous analyses recorded by different investigators, who have invariably found that the amount of resin in the latex of *Castilloa elastica* is very large in the young trees, but gradually diminishes with age, until after the eighth year or so the tree yields rubber of good quality. Practical experiments in the cultivation of *Castilloa elastica* fully support this conclusion. The age of the " old trees " under notice was not stated, but the amount of resin present in the rubber, viz., 15·8 per cent., is much greater than is permissible in rubber of good quality.

II.—TWO SAMPLES OF FUNTUMIA RUBBER.

Two small samples of rubber, derived respectively from *Funtumia africana* and *Funtumia elastica*, under cultivation in Trinidad, were forwarded to the Imperial Institute by the Superintendent of the Royal Botanic Gardens at the instance of the Government of Trinidad. Mr. Hart stated that the specimens were obtained from seedlings of the two species, 3 years old, and with stems about 3 in. in diameter, and that the latex was coagulated by the addition of alcohol. It was also mentioned that, according to reports from West Africa, *Funtumia africana* produces rubber of inferior quality, whereas *Funtumia elastica* yields an excellent product, and it was therefore desired to ascertain whether this would be the case when the plants were grown in Trinidad. The physical characters of the two specimens certainly tended to support the view that there is a great difference in the quality of the rubber yielded by the two species.

(1.) Rubber from *Funtumia africana*, Stapf.

The specimen was forwarded between watch glasses. It was a very soft, sticky mass, which adhered to the fingers and pulled out in long fine threads; it had a brownish colour externally, but was whitish within.

(2.) Rubber from *Funtumia elastica*, Stapf.

This was a small piece of soft and sticky rubber of dark brown colour; it exhibited good elasticity and fair tenacity. It was much superior in physical characters to the preceding specimen.

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

The following results were obtained on analysis:—

——	——	Calculated on the dry material for comparison.		
	Moisture.	Caoutchouc	Resin.	Dirt.
1. Funtumia africana ...	20·7	39·3	60·0	0·7
2. Funtumia elastica ...	15·1	80·4	15·3	1·3

It will be seen from these figures that the sample of rubber from *Funtumia africana* is greatly inferior to that from *Funtumia elastica*, containing nearly four times as much resin and only half as much caoutchouc as the latter. As the trees of both species were of the same age, this difference in the product appears to be characteristic, and confirms the opinion arrived at in West Africa regarding the value of two species. It would be desirable, however, to examine larger specimens of the rubber derived from older plants.

III.—Samples of Castilloa and Funtumia Rubbers.

These samples of Castilloa and Funtumia rubber, prepared by the Superintendent of the Royal Botanic Gardens, were forwarded to the Imperial Institute for chemical examination and commercial valuation by the Government of Trinidad. Full particulars regarding the collection and preparation of the specimens were furnished in a letter from Mr. Hart.

Seven samples of rubber, five of Castilloa and two of Funtumia, were submitted for examination. These had been prepared by different methods, and in the case of the Castilloa rubber from trees of different age.

Description of the Samples.

No. 2. Funtumia.

"350 c.c. Funtumia latex from trees 4½ years old. This was coagulated with a sufficient quantity of alcohol added gradually and produced 270 grams of wet rubber. 'Wet rubber' is rubber just after coagulation. It drains considerably afterwards, and probably loses 15 to 20 per cent. in weight."

The specimen consisted of two pieces of rubber each approximately 4 in. by 3 in. by 1 in., and together weighing 240 grams. On arrival they were a light brown colour externally, but darkened considerably on keeping; when cut they were slightly porous and quite moist within, but contained no uncoagulated latex; the colour of the freshly-cut surface was a light cinnamon brown, and showed the presence of only a trace of foreign matter. The rubber was soft and slightly sticky, very elastic, but rather deficient in tenacity.

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

No. 3. Castilloa.

"350 c.c. Castilloa latex from trees 4½ years old. Added 150 c.c. alcohol. After coagulation and draining the rubber blackened quickly. Obtained 140 grams of wet rubber."

The specimen consisted of a single piece about 4 in. by 2 in. by 1 in. weighing 95 grams, and was evidently of very inferior quality. The mass was very hard, but could be indented with the finger nail and its shape altered by compression; it was almost black externally, but dark brown within, and small fragments of bark were distributed through it. Small pieces of the material were soft, and exhibited only slight elasticity and very little tenacity.

No. 4. Castilloa.

"350 c.c. of Castilloa latex from trees 4½ years old. Added two litres of water and set to cream for 12 hours. Coagulated with alcohol and obtained 118 grams of wet rubber. This appears brittle. Creamed rubber is always cleaner and whiter than rubber from latex coagulated as gathered. It appears to wash away much proteid matter."

This was very similar to the preceding sample, No. 3, in appearance and characters, but was a little softer and more elastic. It was a single piece about 5 in. by 2 in. by 1 in., weighing 85 grams, which was dark brown externally, but much lighter within, the freshly-cut surface having a glossy appearance.

No. 5. Funtumia.

"50 c.c. of latex of *Funtumia elastica* from trees 4½ years old. Coagulated with heat over lamp. Obtained 42·8 grams of rubber."

The specimen was a small ball of rubber weighing 39 grams. It was of a light brown colour externally, but darkened on keeping; within it was quite white, porous, and contained a considerable quantity of uncoagulated latex. The ball was therefore cut into slices and allowed to dry in the air before analysis. The rubber exhibited satisfactory physical characters; it was rather soft, but very elastic and tenacious, and only slightly sticky.

No. 7. Castilloa.

"500 c.c. Castilloa latex from trees 4½ years old. Poured direct on copper mesh (fine wire) and allowed to drain. Rubber coagulated by air naturally in 48 hours. Was taken off wire and doubled up."

The specimen consisted of a sheet of black rubber, about 12 in. square and ⅛ in. thick, which was slightly mouldy on the surface. It was of very inferior quality, being only slightly elastic, and exhibiting very little tenacity.

No. 9. Castilloa.

"600 c.c. of Castilloa latex from trees over 12 years old.

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

Added alcohol to coagulate. Coagulation appeared imperfect. To be compared with No. 3—old and young."

This specimen consisted of a single piece of black rubber weighing 200 grams. When cut open it was found to be very porous and to contain a considerable quantity of acid liquid; it was therefore cut into slices and air-dried before analysis. It also contained numerous fragments of bark and wood of rather large size, which, on removal, were found to amount to 4·6 per cent. of the total weight. The rubber was very elastic and tenacious, and only slightly sticky.

No. 12. Castilloa.

"Specimen of rubber made from washed and creamed latex of trees 12 years old and over. Coagulated with alcohol. This appears to be the best specimen of Castilloa sent."

The sample was a small piece of black rubber weighing 27 grams; internally it was a dark greyish colour throughout, dry, and quite free from foreign matter. The physical characters of the rubber were very satisfactory; it exhibited considerable elasticity and tenacity, and was not sticky. In appearance and characters it was certainly the best specimen of Castilloa rubber submitted.

Chemical Examination.

The following results were obtained on analysis of the various samples:—

No.	Variety of Rubber.	Age of Trees.	Moisture.	Caoutchouc.	Resin.	Dirt.	Ash included in Dirt.
			SAMPLES AS RECEIVED.				
		Years.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
2	Funtumia ...	4½	29·5	60·2	7·9	2·4	1·37
5	" ...	4½	21·2*	68·5	7·9	2·4	2·08
3	Castilloa ...	4½	10·3	37·1	47·1	5·5	1·47
4	" ...	4½	4·3	41·1	53·8	0·8	0·31
7	" ...	4½	8·0	40·8	45·4	5·8	1·24
9	" ...	over 12	15·2*	70·1	11·7	3·0†	0·79
12	" ...	12 & over	2·2	89·1	8·2	0·5	0·25
			CALCULATED FOR DRY MATERIAL.				
2	Funtumia ...	4½	...	85·3	11·2	3·5	1·94
5	" ...	4½	...	86·9	10·0	3·1	2·66
3	Castilloa ...	4½	...	41·3	52·6	6·1	1·64
4	" ...	4½	...	43·0	56·2	0·8	0·32
7	" ...	4½	...	44·4	49·3	6·3	1·34
9	" ...	over 12	...	82·7	13·8	3·5†	0·93
12	" ...	12 & over	...	91·2	8·3	0·5	0·25

* These specimens were air-dried before analysis.

† Exclusive of 4·6 per cent. of bark removed before analysis.

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

It will be seen from these figures that the three specimens of Castilloa rubber, Nos. 3, 4 and 7, which were obtained from trees 4½ years old, contain very large amounts of resin, viz., 52·6, 56·2 and 49·3 per cent. respectively on the dry material, and they would, therefore, possess little value as rubbers. The results of the chemical examination confirm the opinion based upon the physical characters of the specimens, and it is clear from these results that Castilloa trees 4½ years old will not yield a marketable rubber. This conclusion agrees with that arrived at by previous investigators, but it must be remarked that the amount of resin present in the specimens under notice, and also in the small sample of Castilloa rubber from a tree four years old which is dealt with in Part I. of this report, is considerably greater than has been hitherto recorded for Castilloa rubber obtained from trees of the same age growing in other countries. Thus Weber in some experiments conducted at Las Cascadas on the isthmus of Columbia found that the rubber obtained from the trees of *Castilloa elastica* 4 and 5 years old contained 26·47 and 18·18 per cent. of resin respectively, which is about half the amount found in the present case. The much higher percentages of resin found in the specimens from Trinidad may possibly be due to differences of climate, soil, &c. The different methods of preparation followed in the three cases has not influenced the composition of the rubber to any appreciable extent, the only striking difference being that No. 4, which was prepared by creaming, contained very little foreign matter and ash as compared with the other two specimens.

The two samples of Castilloa rubber, Nos. 9 and 12, which were obtained from trees 12 years old and upwards, were of much better quality than the preceding, though the amount of resin present, 13·8 and 8·3 per cent., is still higher than is usually found in the best qualities of this variety of rubber. Specimen No. 12 is the best of the series both as regards chemical composition and physical characters.

Both specimens of Funtumia rubber, Nos. 2 and 5, are presumed to have been obtained from *Funtumia elastica*, though this is only stated definitely of No. 5. The samples were derived from trees of the same age, viz., 4½ years old, the only difference being in the method of coagulation employed; in chemical composition they were very similar. The rubber was rather soft, but was of very fair quality, the amount of resin present in the dry material being 11·2 and 10·0 per cent. respectively. Both samples were very wet when received, and No. 5, which had been prepared by heating, contained a considerable quantity of uncoagulated latex. This defect could,

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

however, be easily remedied, in which case the market value of the rubber would probably be increased.

It appears from these experiments that the trees of *Funtumia elastica*, under cultivation in Trinidad, will yield a marketable rubber at the age of 4½ years, whereas the product obtained from *Castilloa elastica* trees of the same age would possess little commercial value.

Commercial Valuation.

Samples of the four rubbers suitable for commercial valuation, viz., the two Funtumia rubbers, Nos. 2 and 5, and the two Castilloa rubbers, Nos. 9 and 12, were submitted to brokers, who were informed of the results which had been obtained by chemical examination. The brokers report that at the present time the rubbers would have the following values in the London market:—

No. 2 Funtumia	... ...	2s. 6d. per pound.
No. 5 „	... ...	2s. 2d. „
No. 9 Castilloa	... ...	2s. 4d. „
No. 12 „	... ...	2s. 9d. „

They observe that there has recently been a considerable scarcity of medium qualities of rubber in the London market, and that consignments of similar quality to these samples would command a ready sale at the present time.

The results furnished by the examination of the various samples of Castilloa and Funtumia rubber, so carefully and systematically collected and prepared by Mr. Hart, are of considerable scientific interest, and are of obvious practical importance, especially in establishing the conditions which must be secured in order to produce rubber of first-rate quality.

IV.—SAMPLE OF CASTILLOA RUBBER PREPARED BY WEBER'S METHOD.

This sample of rubber of *Castilloa elastica* was forwarded to the Imperial Institute by the Government of Trinidad, and had been prepared by the Superintendent of the Botanic Department according to the method suggested by Dr. C. O. Weber, which consists in the addition of formaldehyde to the creamed latex. The following particulars were supplied regarding the exact procedure adopted:—

"Latex from Castilloa trees 14 to 16 years old, 500 cc., creamed in four times its volume of clean water, three times in succession to remove albuminoids. Added 20 cc. of commercial formalin to latex when creamed on last lot of water. No cohesion took place until 96 hours after mixing. Rubber then lifted and pressed. Cold water was used."

The Experimental Cultivation of Castilloa and Funtumia Rubbers in Trinidad.

The specimen was a semicircular cake, 4 in. in diameter and 1 in. in thickness, which weighed about 50 grams. Externally it was a light brown colour, but within it was quite white, perfectly dry and free from foreign matter. The rubber exhibited very satisfactory physical properties; it was not sticky, and was very elastic and tenacious.

The following results were obtained on chemical examination:—

——	Sample as received.	Calculated for Dry Material.
	Per cent.	Per cent.
Moisture	9·5	—
Caoutchouc	82·6	91·2
Resin	7·4	8·2
Dirt	0·5	0·6
Ash (included in dirt)	0·26	0·29

These figures are practically identical with those furnished by sample No. 12 of the previous consignment, which was prepared by coagulating the washed and creamed latex by alcohol. The physical characters of the two specimens were also very similar, the only difference being that the sample prepared by Weber's method was much lighter in colour.

The brokers also regarded the two specimens as of equal value, and quoted for each a price of 2*s.* 9*d.* per pound.

THE RUBBER RESOURCES OF THE SOUDAN.

The rubber industry was formerly one of the principal sources of revenue in certain districts of the Soudan, notably in the Bahr-el-Ghazal, and it was therefore to be anticipated that the trade in this product would be revived so soon as the internal condition of the country permitted. Colonel Sparkes, who commanded the expedition which successfully occupied the northern portions of the Bahr-el-Ghazal province during 1900—1901, reported that rubber trees were very abundant in many of the districts visited by him, and that according to the statements of natives the trees occur in large numbers throughout the entire province. Small samples of the rubber were collected during the expedition, and these were forwarded by the Soudan Government to the Foreign Office for transmission to the Imperial Institute, so that the composition and commercial value of the product could be determined as a preliminary step towards the re-opening of the industry.

The tree from which the rubber was obtained is described as a thick creeper occurring abundantly all over the Bahr-el-Ghazal between Tonj River and Dem Zubeir, except in the Dinka districts lying to the north, and it is known to the natives of the various tribes as "Ndala," "Odiloh," "Ngeleh" and "Atilob." At a later stage of the enquiry Mr. Broun, the Director of Woods and Forests in the Soudan, was despatched to the Bahr-el-Ghazal to report upon the possibilities of re-opening the rubber trade of the district, and from his investigations it appears that the tree in question is *Landolphia owariensis* Beauv., var. *tomentella*, a well-known rubber producer in tropical Africa.

The examination of the two samples of rubber collected by Colonel Sparkes was conducted by the Scientific and Technical Department of the Imperial Institute, and the results obtained showed them to be of good quality, so far as chemical composition was concerned. Very favourable opinions were also expressed by brokers, who stated that if sent of uniform quality and free from admixture with vegetable matter the rubber would command a good price in the London market (see report in "Technical Reports and Scientific Papers" of the Imperial Institute, p. 154).

A firm of rubber manufacturers to whom the samples were submitted expressed a desire to obtain a small shipment of about 1 cwt. of the rubber for practical trials, and intimated that they would be prepared to pay the market price for the consignment. The request was communicated to the Soudan Government, and in response a consignment of about 100 lb. of the rubber was forwarded to the Imperial Institute for the purpose indicated.

This rubber was made up in two forms, viz., balls and cylindrical rolls. The balls were about 1½ inches in diameter, and were dark reddish-brown externally but pinkish-white and slightly

The Rubber Resources of the Soudan.

moist within; a small quantity of extraneous vegetable matter was present. The rubber was not sticky, it was rather hard in the mass, but small pieces exhibited very good elasticity and tenacity. The rolls were about 4 inches in length and 1 inch in diameter, and a number of them were attached together to form a small bundle. The rubber made up in this form was very similar in appearance and character to that sent in balls.

Samples of both balls and rolls were chemically examined in the Scientific and Technical Department of the Imperial Institute, so that the composition might be recorded, and the following results were obtained:—

	Samples as received.		Calculated for dry material.	
	Balls.	Rolls.	Balls.	Rolls.
	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	15·7	17·8	—	—
Caoutchouc	71·5	69·5	84·8	84·6
Resin	7·3	7·4	8·7	8·9
Dirt and insoluble matter	5·5	5·3	6·5	6·5
Ash included in dirt ...	1·19	1·16	1·44	1·41

These figures showed that the balls and rolls were practically identical in composition, and that the rubber was of very fair quality, although the percentages of resin were higher than in the small samples which were first forwarded.

The consignment was then placed in the hands of the brokers who had obtained the valuations on the previous samples, and the rubber was sold by them at 3*s.* 5½*d.* per lb., the price of Para rubber being about 4*s.* 4*d.* per lb. at the time. The price obtained must be considered extremely satisfactory, being quite equal to that quoted for the best varieties of second grade rubber, and proves that the rubber from the Bahr-el-Ghazal, if carefully collected and prepared, will command a good price in the London market. This view is confirmed by the fact that another recent consignment of rubber from the Soudan which came through the ordinary channels of trade was sold for 3*s.* 6*d.* per lb.

The Soudan Government has already taken action to prevent the destruction of the rubber trees through reckless methods of collection, and by a Decree of 1st May, 1903, the rubber forests throughout the Soudan, with the exception of those of Kordofan, have been placed under official management. This step will doubtless have a very beneficial effect upon the future of the rubber industry in the Soudan.

CARUÁ AND MAKIMBEIRA FIBRES FROM BRAZIL.

Samples of these fibres were forwarded by the British Consul at Bahia to the Foreign Office, and were transmitted to the Imperial Institute for chemical examination and commercial valuation. The specimens were accompanied by a memorandum from the Consul, which contained the following particulars relating to their origin and mode of preparation.

Caruá fibre is stated to be derived from a plant which is common in the northern parts of the State of Bahia, and thrives best at high altitudes. The extraction of the fibre is carried out by the natives in the following manner. After the stems have been cut the outer bark is removed, and the rough fibre is retted by steeping it in water for 15 days and is afterwards scraped with a blunt knife. The green fibre thus obtained is dried and twisted into ropes, which hitherto have only been employed locally. The preparation of this fibre by machinery has been commenced recently by a British firm, and it is expected that large samples of the properly prepared material will shortly be available. It is also stated that experiments are being carried out on the cultivation of the plant.

Makimbeira fibre is derived from a plant which is closely allied to Caruá, and grows abundantly in proximity to it. This fibre is of a softer quality than that of Caruá.

The samples submitted were as follows:—

No. 1. Caruá fibre, prepared by natives, hulk and pulp removed. A white, fairly strong fibre, but not well prepared. Length of staple about 6 ft.

No. 2. Hand-made rope from green Caruá fibre.

No. 3. Makimbeira fibre prepared by natives, cuticle and pulp partially removed. In its general appearance this sample, which was very small, closely resembled No. 1.

A portion of the Caruá fibre (sample No. 1) was cleaned as far as possible by hackling, and was submitted to chemical examination by the Scientific and Technical Department of the Imperial Institute with the following results:—

Moisture	8·4 per cent.
Ash	3·1 ,,
Loss on (*a*) hydrolysis	25·6 ,,
,, (*b*) ,, ...	33·7 ,,
,, acid purification	15·3 ,,
,, mercerisation	23·5 ,,
Gain on nitration	17·3 ,,
Cellulose	69·8 ,,
Length of ultimate fibre	2-5 mm.

Caruá and Makimbeira Fibres from Brazil.

This fibre contains little or no ligno-cellulose, which is shown especially by the pale colour of the nitration product and by the fact that when the chlorinated product obtained in the course of the estimation of cellulose is acted on with sodium sulphite, only a faint pink coloration is produced. The considerable losses sustained by the fibre on hydrolysis and mercerising show that it is very sensitive to attack by alkali, and is, therefore, not likely to be so durable as some other fibres.

The sample of Makimbeira fibre was too small to admit of chemical examination.

The samples have been submitted to fibre brokers, who agree in stating that though of good length and fair colour they are irregular in strength as the result of faulty preparation, and for this reason the fibres in their present state would only be suitable for admixture with better materials for the manufacture of cordage. The Caruá fibre was valued at from 10*l.* to 13*l.* per ton, and the hand-made rope, which appears to have been prepared from selected fibre, at 25*l.* per ton. The Makimbeira fibre was stated to be worth from 13*l.* to 20*l.* per ton.

From the foregoing report it is evident that, if better prepared, these fibres might be of some commercial value, especially if a constant supply of average quality can be maintained.

Confirming this opinion, information has since been received that a consignment of dressed Caruá fibre has recently realised the price of 31*l.* per ton in public auction in London.

Since the botanical origin of these fibres was not definitely known, application was made to the Consul at Bahia for specimens of the plants from which they are derived in order that their identity might be determined. These plants were received in due course and were transmitted for identification to the Royal Gardens, Kew.

It was stated that both plants belonged to the Pine-apple Order, *Bromeliaceae*, that plants of this order abound in many parts of South America, and their fibres appear to be employed locally, but whether these have any commercial value has yet to be ascertained. The Caraguatá, produced by *Bromelia argentina*, which is abundant in the Argentine Republic and in Paraguay, is a case in point. Some account of it is given in the "Collected Papers on Vegetable Fibres from the Kew Bulletin," 2nd ed., pp. 110-114. The Caruá, or more correctly, Caroá fibre, is said to be produced by *Neoglaziovia variegata*, Mex. The Makimbeira is probably an allied species, but this could not be accurately determined owing to the absence of flowers on the specimen submitted for identification.

THE FIBRE OF *CRYPTOSTEGIA GRANDIFLORA* FROM MADRAS.

This sample of fibre was forwarded to the Imperial Institute for examination by the Agri-Horticultural Society, Teynampett, Madras. It is stated that the plant occurs wild throughout the Teynampett district. The present sample of fibre is said to have been prepared by steeping the branches in water for three days; the fibre was then easily removed, and was afterwards washed with water.

The sample consisted of about three ounces of a nearly white. fine, strong fibre with a staple of average length, 16–20 inches. In its general character and appearance this fibre resembles that of *Marsdenia tenacissima* on which a report was recently supplied by the Imperial Institute to the Government of India (Imperial Institute Bulletin, No. 3, p. 121). The results of the chemical examination by the Scientific and Technical Department of the Imperial Institute show that these fibres are also very similar in their chemical properties and behaviour. The two plants are allied botanically, both being climbing shrubs of the Natural Order *Asclepiadeæ*.

The results alluded to are given below together with those obtained in the case of *Marsdenia tenacissima* :—

		Cryptostegia Fibre per cent.	Marsdenia Fibre per cent.
Moisture		7·9	7·7
Ash		0·95	1·5
a-Hydrolysis	Loss	5·2	7·8
b-Hydrolysis	„	9·8	8·9
Mercerisation	„	4·3	4·9
Acid purification	„	1·2	3·5
Nitration	Gain	49·0	53·9
Cellulose		92·0	91·5
Length of ultimate fibre		10-60 mm.	10-30 mm.

The fibre contains little or no ligno-cellulose; this is shown especially by the absence of colour in the nitration product, and by the fact that when the chlorinated product, obtained in the course of the estimation of cellulose, is treated with sodium sulphite, no red coloration is produced. It is exceptionally resistant to the action of alkali, as is indicated by the comparatively small losses sustained on hydrolysis and mercerising. The remarkable quality of the fibre is shown also by the unusually high percentage of cellulose, and by the large increase of weight on nitration. In all these particulars, the fibre of Cryptostegia resembles that of Marsdenia. The ultimate fibre, however, is of

The Fibre of Cryptostegia grandiflora from Madras.

greater length than that of Marsdenia, its average length being about 30 mm. (1·2 inches) which is equal to that of flax.

The sample has been submitted to leading fibre brokers for commercial valuation, who report that the fibre is of good quality, and worth about 30*l.* per ton. They are of opinion that the fibre is likely to prove of considerable value, but that its commercial possibilities can only be arrived at by submitting it to manufacturing tests, and they ask to be supplied with two or three bales for this purpose. They point out that the fibre should be as long and even as possible, and that the long and short filaments should be kept separate; in the present sample, the length is very irregular.

Specimens of the rubber furnished by *Cryptostegia grandiflora* have also been received recently from India, and have been examined in the Scientific and Technical Department of the Imperial Institute. The results of the examination of these rubbers will be published subsequently.

THE FIBRE OF *AGAVE AMERICANA.*

In the last issue of this Bulletin, p. 120, an account was given of the composition and properties of the fibre of a plant forwarded from Assam under this name. The Imperial Institute has now been informed by the Officiating Reporter on Economic Products to the Government of India that the identity of the plant in question is under investigation and that it is probably not *Agave americana*, as was originally supposed.

THE VOLATILE OIL OF THE BARK OF *CINNAMOMUM PEDATINERVIUM* OF FIJI.

The genus *Cinnamomum* of the Natural Order *Lauraceae* comprises a number of species of evergreen, aromatic trees and shrubs, many of which yield useful and important volatile or essential oils. As examples, there may be mentioned *Cinnamomum Camphora*, the source of camphor, *C. zeylanicum* which yields oil of cinnamon, and *C. Cassia* which furnishes the oil of cassia or Chinese cinnamon.

Cinnamomum pedatinervium is a tree indigenous to the Fiji Islands, the bark of which possesses a pleasant aromatic odour due to the presence of a volatile oil. The following account of the tree is given by Berthold Seemann in his "Flora Vitiensis" (p. 202).

The Volatile Oil of the Bark of Cinnamomum pedatinervium of Fiji.

"The bark of the 'Macou,' as it is termed in the Bau dialect, 'Mou' in that of Kadavu, and 'Maiu' in that of Namosi, is a kind of Cassia bark, which may prove of commercial importance, and is used by the Fijians for scenting cocoa-nut oil. The tree yielding it is about 30 feet high, four to five inches in diameter and is met with above an elevation of 1,500 ft., in dense virgin forests. I found it on Buke Levu, island of Kadavu, and on Voma peak, Viti Levu; and Mr. Pritchard received fine specimens from the islands of Gau, where they had been collected by W. Berwick, a coloured man, residing there. The bark has a fine aromatic smell and flavour, a light brown colour, is thicker than that of the cinnamon of commerce, and resembles some of the laurineous barks, such as the Sintoc and Culilawang, brought from the Moluccas. In Namosi, it is used as a sudorific. Unfortunately, I did not see the tree in flower, and hence am unable to determine whether the 'buds' are equal to the best 'Cassia buds' of commerce. The resemblance of the Fijian names to that of 'Massoy,' given to a fine quality of Cassia bark, from New Guinea, deserves investigation."

A consignment of this bark was sent from Suva, Fiji, to the Imperial Institute in order that its volatile oil might be extracted and submitted to examination and commercial valuation.

An investigation of this oil has been carried out in the Scientific and Technical Department of the Imperial Institute, and a complete chemical examination of the constituents of the oil has been made by Dr. Ernest Goulding (Journal of the Chemical Society, 1903, vol. 83, pp. 1093—1101).

The results may be summarised as follows:—On distillation in a current of steam the bark yields nearly 1 per cent. by weight of a volatile oil which is almost colourless when first distilled, but gradually assumes a yellowish brown colour. It has a sweet, aromatic odour and a pungent, spicy taste. It has a rotatory power of $-4{\cdot}78^\circ$ at 15° in a 100 mm. tube, or $[\alpha]_D - 4{\cdot}96^\circ$; when, however, the oil is heated to 170° and allowed to cool again, the rotatory power is increased to $-5{\cdot}48^\circ$ or $[\alpha]_D - 5{\cdot}66$. Its index of refraction is 1·4963 at 15°. It is freely soluble in the usual organic solvents, and is neutral to litmus. When the oil is cooled to -12° for an hour in a mixture of ice and salt, no solid substance separates.

The chemical examination of the oil showed that its composition is approximately as follows:—

Terpene, 15—20 per cent.
Alcohols (wholly, or in part, linalool), 30 per cent.
Esters, 1·5 per cent.
Safrole, 40—50 per cent.
Eugenol, 1 per cent.
Eugenol methyl ether (?), 3 per cent.

The Volatile Oil of the Bark of Cinnamomum pedatinervium of Fiji.

The pleasant odour of the oil renders it probable that it would be of considerable service in perfumery, and especially for scenting toilet soaps.

The oil of *Cinnamomum pedatinervium* is much superior in aroma to that obtained from sassafras root, which has a somewhat similar composition but contains a smaller proportion of safrole. This oil, therefore, should be worth at least as much as oil of sassafras, the wholesale price of which, in small quantities, is about 3*s.* per lb.

THE COMMERCIAL UTILISATION OF *HYOSCYAMUS MUTICUS* FROM EGYPT AND INDIA.

The common henbane of Europe, *Hyoscyamus niger*, has long been used in medicine, and in common with many other members of the natural order *Solanaceae*, it has been found to contain the alkaloids hyoscyamine, atropine, and scopolamine. Another species of the same genus, viz., *Hyoscyamus muticus*, which occurs in certain districts of India, has been employed in native medical practice, and was reported to be a particularly virulent drug, in consequence of which it was named *Hyoscyamus insanus* by Dr. Stocks. The nature of the alkaloid present in this species had never been determined, however, and the subject was therefore investigated in the Scientific and Technical Department of the Imperial Institute at the instance of the Reporter on Economic Products to the Government of India.

The specimen of *Hyoscyamus muticus* forwarded for examination was obtained from Sind, and consisted of the entire aërial portion of the plant. The chemical enquiry proved that the entire air-dried plant contained 0·1 per cent. of the alkaloid hyoscyamine without any atropine or scopolamine, and that in consequence the hyoscyamine could be isolated from it in a pure condition much more easily than from other atropaceous plants. Since there is a considerable demand for hyoscyamine in medicine it was thought that the plant would probably prove to be an important source of the alkaloid, especially if it could be obtained in quantity from India. This view was communicated to the Government of India so that the necessary enquiries could be made, and an account of the investigation was given in a paper by Professor W. R. Dunstan, F.R.S., and Mr. H. Brown, which was read before the Chemical Society (Proc.. 1898, *14*, 210; Trans. 1899, *75*, 72).

As a result of this publication, Dr. Gadamer shortly afterwards communicated a brief paper to the Archiv der Pharmazie (1898, *236*, 704), giving an account of the results which he had obtained in the examination of a sample of *Hyoscyamus muticus* from Egypt. He confirmed the conclusions that hyoscyamine is the only alkaloid

The Commercial Utilisation of Hyoscyamus Muticus from Egypt and India.

present in the plant, and that it can be easily isolated in a pure condition, but stated that the amount of alkaloid present in the Egyptian plant was very much greater than had been recorded for the specimen from India. Using Keller's volumetric method of estimation, Gadamer found 1·34 per cent. of hyoscyamine in the capsules and seeds, 1·39 per cent. in the leaves and 0·57 per cent. in the stems. These percentages of alkaloid are much higher than had been previously recorded for any atropaceous plant, and it was clear that, if they could be taken as representative, the Egyptian *Hyoscyamus muticus* would be an exceedingly valuable source of hyoscyamine.

A little later a specimen of the Egyptian plant was forwarded to the Imperial Institute for examination by the late Mr. E. A. Floyer, Director of Telegraphs in that country. This was examined in the Scientific and Technical Department in a similar manner to the previous specimen from India, and it was again found that only hyoscyamine was present, but in much larger proportion than in the Indian plant. The seeds yielded 0·87 per cent. of alkaloid and the mixed stems and leaves 0·59 per cent., these figures representing the weight of crystalline hyoscyamine obtained. (*See* paper by Dunstan and Brown in Journal of Chemical Society, Trans. 1901, *79*, 71.)

Two other samples of the stems and leaves of the plant were subsequently forwarded by Mr. Floyer, and the examination of these fully confirmed the previous analyses, the percentages of hyoscyamine found being 1·21 and 0·98 per cent. in the leaves and 0·7 and 0·54 per cent. in the stems.

There was therefore no doubt that the Egyptian *Hyoscyamus muticus* contained a very large percentage of hyoscyamine, which could be easily obtained in a pure condition, and that consequently the plant would form a valuable commercial source of that alkaloid or of atropine, which can readily be prepared from hyoscyamine. The plant is abundant in the Egyptian desert, and if necessary large quantities could be grown to meet a commercial demand. Mr. Floyer at once took steps to procure supplies of the plant, and the matter was brought to the notice of alkaloid manufacturers in Europe and America. Consignments of the plant were afterwards supplied to several firms for trial, and a commercial demand, which has continued to grow steadily, was thus created. Recently several bales of the plant were sold at the public drug auctions in London. An analysis of the leaves from one of these commercial consignments has been published by Messrs. Southall Brothers, and Barclay of Birmingham, who found them to contain 0·66 per cent. of alkaloid by weight, or nearly six times as much as a sample of the leaves of the English plant, *Hyoscyamus niger*, analysed for comparison.

Latterly attention has been devoted to the plant from the medical and pharmaceutical point of view, and at the British

The Commercial Utilisation of Hyoscyamus Muticus from Egypt and India.

Pharmaceutical Conference in July last a paper was read by Messrs. Ransome and Henderson dealing with the possibility of employing *Hyoscyamus muticus* for the manufacture of galenical preparations, such as tincture and extract. The analyses made by these workers fully confirm the figures already quoted. A tincture of the plant standardised to contain 0·01 per cent. of hyoscyamine has been suggested for medicinal use, and is now undergoing trial by various medical men and at several hospitals.

It is evident from this account that the investigation of *Hyoscyamus muticus* in the Scientific and Technical Department of the Imperial Institute has established the very valuable nature of the Egyptian plant, which is now being utilised as a source of hyoscyamine or atropine. A second sample of the Indian plant has been forwarded to the Imperial Institute for further investigation with reference to the great difference in the amount of alkaloid present in the two varieties. This enquiry is now in progress and will be reported upon in due course. It appears that *Hyoscyamus muticus* is not so abundant in India as in Egypt, but enquiries upon this point are still proceeding.

PETROLEUM FROM TRINIDAD.

The presence of numerous pitch lakes and deposits of natural asphalt in Trinidad has long caused petroleum experts to suspect the occurrence of deposits of petroleum in the island. During the last two years a considerable amount of preliminary exploration work has been done, and quite recently two wells and a "seeping" pit have been sunk at Guayaguayare, where escapes of oil and natural gas were noticed. The wells are over 1,000 feet deep and at present yield a fair quantity of oil per day. The "seeping" pit is near to well No. 2, has a capacity of 1,800 cubic feet, and when emptied refills itself in the course of two or three days. The quantities of oil so far obtained at Guayaguayare are considered so satisfactory that further explorations are being carried out in the same district. The discovery of petroleum in the island is a matter of considerable importance, and consequently the Governor of Trinidad, Sir A. Moloney, who has taken a great interest in the opening up of these deposits, forwarded in July last to the Colonial Office samples of the oil obtained from both wells, with the request that they might be examined in the Scientific and Technical Department of the Imperial Institute, and their composition and commercial value ascertained.

The samples were received from the Colonial Office in August, 1903, together with the following information regarding their origin.

Petroleum from Trinidad.

"Sample A is oil obtained from No. 1 well sunk at Guayaguayare last year (1902), and as it was pumped some months ago it will probably have lost a considerable proportion of its petroleum spirit."

"Sample B is from a natural spring some distance from the spot where sample A was obtained. This oil has already been analysed locally and is quite distinct in character from sample A, and as this sample was obtained a few days ago during the rainy season, it may probably contain a certain percentage of water."

Description of samples.

A.—Labelled—"Trinidad Crude Petroleum. Sample A." The specimen consisted of about one gallon of a thick dark brown oil having the characteristic smell of crude petroleum, but free from any unpleasant odour or sulphur compounds. It was quite liquid at the ordinary temperature. Its specific gravity was 0·920 at 20° C. and the flash point (Abel-Pensky test) was 21·5° C. (30·7 Fah.).

B.—Labelled—"Trinidad Crude Petroleum. Sample B."

This sample measured about one gallon, and was a thick dark brown oil with a well-marked fluorescence. It possessed no unpleasant odour. The specific gravity was 0·8686 at 20° C., and the flash point (Abel-Pensky test) 71·56 (150·7° Fah.).

Chemical examination.

A representative specimen of sample A gave the following results on fractional distillation:—

Sample A.

Light petroleum, boiling below 150° C.	11·1	per cent.
Kerosene (burning oil) boiling between 150° C. and 270° C.	38·0	"
Heavy oil, boiling above 300° C. at atmospheric pressure	20·0	"
Heavy oil obtained by further distillation under reduced pressure...	23·0	"
Coke (by difference)	7·9	"

The *light petroleum* was almost colourless and possessed a pleasant odour; its specific gravity was 0·798 at 20° C., and it absorbed 4·8 per cent. of bromine, indicating that a small quantity of unsaturated hydrocarbons was present.

The *kerosene* was slightly yellow in colour, and had a faint unpleasant odour. Both these objectionable properties were removed by shaking the oil first with sulphuric acid and then with an aqueous solution of caustic soda. The refined oil so obtained was colourless. Its specific gravity was 0·864 at 20° C., and flash point (Abel-Pensky test) 57° C (134·6° Fah.).

The *heavy oil* was a thick reddish-brown liquid showing a strong

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green fluorescence and possessing an unpleasant odour of sulphur compounds and of pyridine. After treatment with acid and alkali and separation of the large amount of tarry matter there was left a thick, slightly yellow oil, free from objectionable odour. An attempt was made to further purify this fraction by re-distillation under reduced pressure, but in doing so decomposition of the less volatile hydrocarbons occurred with the formation of inflammable gases and of lower-boiling hydrocarbons.

A representative specimen of sample B gave the following results when fractionally distilled :—

Sample B.

Light petroleum boiling below 150° C.	0·2 per cent.
Kerosene (burning oil) boiling from 150° to 300° C.	70·0 „
Heavy oil (*a*) boiling above 300° C. under atmospheric pressure	18·2 „
Heavy oil (*b*) boiling above 300° C. under reduced pressure	9·2 „
Coke (by difference)	2·4 „

The *light petroleum* so far as could be judged from the small quantity available was similar to that obtained from sample A, but it contained a small quantity of water.

The *kerosene*, as distilled, was light yellow but became colourless after treatment with sulphuric acid followed by agitation with an aqueous solution of caustic soda. The refined oil was colourless, had a pleasant petroleum odour, a specific gravity of 0·838° at 20° C., and flash point (Abel-Pensky test) of 68° C. (154·4° Fah.).

The *heavy oil* had a reddish-brown colour with a slight green fluorescence. The colour was readily removed by treatment with sulphuric acid and solution of caustic soda. The refined oil so obtained was a colourless, slightly viscous liquid having the specific gravity 0·865 at 20° C.

These results indicate that the two samples of Trinidad petroleum are essentially different in character, sample A, obtained from well No. 1, containing 11·1 per cent. of light petroleum, and only 38 per cent. of kerosene, whilst sample B, obtained from a natural spring in the same neighbourhood, contains a minute quantity of light petroleum and 70 per cent. of kerosene. It may, however, be the case that this difference is to be accounted for by gradual loss by evaporation of the lower boiling hydrocarbons from the natural reservoir which is the source of the spring from which sample B was drawn, whilst well No. 1 may tap a deeper reservoir from which a correspondingly smaller loss of this kind has occurred. In the absence of any specific information, however, as to the depth of the well, or of the conditions under which the samples were drawn and stored, it is impossible to offer any definite

Petroleum from Trinidad.

opinion on the cause of this difference in the composition of the two samples. Similar variations have been observed in the case of samples of petroleum derived from other districts in Trinidad, the specific gravity varying from 0·938 to 0·971 and the flash point from 60° Fah. to 190° Fah.

Sample A more closely resembles Russian than American petroleum. The former contains from 6 to 20 per cent. of light petroleum, and 30 to 40 per cent. of kerosene, whilst the latter yields usually from 50 to 70 per cent. of kerosene.

Sample B, on the other hand, more nearly resembles Canadian petroleum in its small yield of light petroleum, but it contains more kerosene than the Canadian product. It also resembles the oil obtained in Timor, in the Eastern Archipelago, which has the specific gravity of 0·825, and contains 67·5 per cent. of kerosene, 30·7 per cent. of heavy oil and no light petroleum.

Both these samples of Trinidad petroleum represent valuable commercial products. If the oil-field should on further examination prove to be extensive, this discovery of petroleum will no doubt be of great importance to the Colony.

NATURAL PITCH OR MANJAK FROM TRINIDAD.

This sample of manjak was forwarded to the Imperial Institute in September, 1902, by the Superintendent of the Botanical Department, Trinidad, in accordance with instructions received from the Government, and has been examined in the Scientific and Technical Department at the request of the Colonial Office.

The sample was obtained from a deposit of natural pitch recently discovered in Trinidad, and it was especially desired to ascertain what ingredient should be added to this product in order that it might liquefy readily when heated, so that its utilisation might be made possible.

The specimen of manjak weighed about five pounds, and consisted of, roughly, cubical lumps of a black, somewhat lustrous mineral. It showed slight lamination and an irregular fracture, and in general had the appearance of a bituminous coal of good quality, but was more friable.

The material had no definite melting point, but became soft at 220° C. (428° F.), and, on cooling, solidified to a hard, homogenous lustrous mass, showing a conchoidal fracture.

The manjak was almost completely soluble in chloroform, leaving only 4·75 per cent. of residue, containing mere traces of organic matter. When heated, it furnished at a temperature of 360° C. (680° Fah.) 8·10 per cent. of a dark-brown oil.

Natural Pitch or Manjak from Trinidad.

On analysis, the following results were obtained :—

	Per cent.
Fixed carbon	55·15
Volatile matter	40·92
Ash	3·55
Moisture	0·38

In order to determine the nature of the bituminous constituents, the manjak was extracted first with acetone, which removes "petrolene," and subsequently with chloroform, which dissolves "asphaltene."

	Per cent.	
Acetone extract (petrolene) ...	12·06	Total bituminous matter, 95·25 per cent.
Chloroform extract (asphaltene)	83·19	
Insoluble residue	4·75	

Commercial Valuation of Trinidad Manjak.

The principal purposes to which highly bituminous asphalts of the manjak type are applied are: the coating of iron as a preventitive of rust, the preparation of black varnishes by solution in turpentine oil or similar solvents, as electrical insulating materials, and as ingredients in paving asphalts. For the first three of these purposes it is essential that the material should possess a low melting point. This property is dependent upon the amount of "petrolene" contained in the bitumen of the material, and this, as indicated by the analyses already given, is very low in the case of the Trinidad manjak, in which respect, as the following table shows, it compares very unfavourably with similar products already known in commerce :—

	Total Bitumen.	Melting Point of Bitumen.	Percentage of Petrolene in Bitumen.	
Venezuelan pitch	96·1	150° Fah.	69·1	per cent.
Trinidad asphalt	35·2 to 61·5	192° Fah.	41 to 75·3	„
Trinidad manjak	95·25	428° Fah.	12·6	„

For the preparation of paving asphalt from the Trinidad manjak it would be necessary to mix it with mineral matter such as ground limestone or sand, and it is doubtful whether such a mixture could be manipulated as a paving material on a commercial scale owing to the high melting point of the manjak and to its lack of binding power.

Although the results of the chemical examination of the sample of manjak indicated that in its crude form it was not likely to be suitable for industrial use, samples of the material were submitted both to asphalt dealers and to varnish makers for commercial valuation.

It was reported to be unsuitable for varnish-making since it could not be thoroughly melted in large quantities, and the

Natural Pitch or Manjak from Trinidad.

varnish obtained from it did not produce a sufficiently brilliant "coat" to be saleable.

The asphalt dealers, who are principally interested in the use of this product as a "paving" or insulating material, state that the manjak is difficult to work, but that they are willing to make further trials with a large consignment, and for this purpose it is suggested that a further sample of about one hundredweight of the material should be forwarded to the Imperial Institute.

The chemical examination of this manjak has shown that the difficulties experienced in its technical employment are due to its deficiency in liquid bituminous matter (petrolene). It is stated that in the United States deficiencies of this nature in natural asphalts are frequently remedied by the incorporation of a certain proportion of the "residuum" obtained in the distillation of crude petroleum with the asphalt, previously softened by heat. The material sold as "petroleum residuum" varies greatly in composition, but the specifications adopted by the Washington (U.S.A.) District Council regarding the properties of "petroleum residuum" suitable for addition to paving asphalts may be taken as a guide in selecting a material for admixture with this manjak. These state that the "residuum" should have a flash point of not less than 300° Fah., as determined in a New York closed oil tester, and when heated for 30 hours at 400° Fah. should yield not more than 10 per cent. of distillate, and "that the residue when cold should not be coarsely crystalline."

It would be worth while to carry out practical experiments on these lines with this manjak in Trinidad, in order to ascertain whether the incorporation of "petroleum residuum" with it could be carried out at a sufficiently low cost. In this connection it may be mentioned that a suitable "residuum" could probably be obtained from the crude petroleum now being worked in the Colony, samples of which have been recently examined in the Scientific and Technical Department of the Imperial Institute. (*See preceding report.*)

II.—GENERAL NOTICES.

(*Prepared by the Staff of the Scientific and Technical Department.*)

REPORT ON THE PRINCIPAL PETROLEUM RESOURCES OF THE BRITISH EMPIRE.

I.—Canada.

The Canadian petroleum industry originated about the same time as that of the United States. The first important well was sunk at Oil Springs, County Lambton, Ontario, in 1862, and since that time this district has remained the principal source of petroleum in the Colony. The output of petroleum in Canada has steadily increased, but this increase has only been maintained by continually sinking new wells, as the yield per well fell off greatly after the first few years from the establishment of the industry. The following table shows the output of crude and refined oil in Canada in the last five years and the imports into the Colony of American refined oil:—

—	Output.		Imports of Refined Oil.
	Refined Oil.	Crude Oil.	
	Gallons.	Gallons.	Gallons.
1897	10,506,526	25.015.538	8.415,302
1898	10,796,847	25,706,778	9,074,311
1899	11 005,414	26,203,366	10,394,208
1900	11.741.354	27.995,605	9,633,647
1901	11,197,315	26,660,274	11,082,822

The exports of Canadian petroleum are unimportant, and are stated to be practically confined to refinery products such as paraffin scale and wax.

Nature of Canadian Petroleum.

The crude petroleum is a heavy, dark brown oil with a specific gravity ranging from 0·804 to 0·808, although specimens of specific gravity 0·860 have been obtained. Owing to the presence of sulphur compounds the crude oil has a most unpleasant odour, and great ingenuity has been displayed by Canadian refiners in devising methods for the production of a refined oil free from objectionable odour. The average composition of the crude oil is as follows:—

	Specific gravity	Per cent.
Naphtha	0·735 ...	12·5
Lamp oil	0·820 ...	35·8
Lubricating oil ...	— ...	43·7
Hard paraffin ...	— ...	3 0

The yields of these products obtained in actual practice are, however, considerably less, and were stated in 1889 to be approximately as follows:—

	Per cent.
Benzin and naphtha	1·6
Lamp oil	38·7
Paraffin and heavy oils	25·3
Waste	34·4

Canadian petroleum at present yields about 40 per cent. of illuminating oil. The Imperial Oil Company of Sarnia manufactures, in addition to this, lubricating oils, cylinder oils, paraffin wax, candles and lubricating greases.

A specimen of petroleum from Westmoreland County, New Brunswick, examined in the Scientific and Technical Department of the Imperial Institute in 1902 had the following composition:—

	Per cent.
Light petroleum (naphtha)	5·6
Kerosene (lamp oil)	28·3
Heavy oils and solid hydrocarbons ...	58·2
Water	7·9

This specimen, the specific gravity of which was 0·857, contained an unusually high percentage of solid hydrocarbons.

DISTRIBUTION OF PETROLEUM IN CANADA.

ONTARIO.

Petrolea and Oil Springs fields. There are indications of the occurrence of petroleum in many parts of the Dominion, but it is only in Ontario that it has been produced in commercial quantities, and there almost entirely in the counties of Kent and Lambton. The principal pools are situated in the latter county, and are known as the Petrolea and the Oil Spring fields. The former covers an area of about 26 square miles. Petroleum is found at depths of from 460 to 480 ft. and 370 to 400 ft. respectively in the two fields. The number of wells at present is said to be between 10,000 and 11,000. When this area was first opened the pressure in the wells was as high as 300 lbs. to the square inch, and spouting or flowing wells frequently occurred. Now, however, the pressure is slight, with the result that the oil runs slowly into the wells, and to keep the output up to the average it has been necessary to sink a large number of wells on a small area. This has been possible owing to the nearness of the petroleum stratum to the surface, and the consequent small cost of sinking wells, and also the economy in working effected by the "jerker" system

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of supplying power from a central station, so that a large number of wells can be pumped from one set of engines. Most of the oil from these fields is refined at Sarnia, but recently another refinery has been opened at Petrolea.

Bothwell Field.

A new and important oil pool, the Bothwell oil field, is situated between the Grand Trunk Railway and Thames River in Kent County. The oil is found in the Corniferous limestone at a depth of about 400 feet. The number of wells at present working is about 240, but the number continues to increase. The production in 1902 varied from 350 to 1,750 gallons per month for each well, and the total output from the whole field was estimated at from 175,000 to 210,000 gallons for the same period.

In 1902 a well, known as the "Gurd gusher," was struck in this field; it produced at first 1,750 gallons per hour, but this declined in the early part of 1903 to 3,500 gallons per day. This well is situated at Chatham, and is 357 ft. deep. A new well recently opened at Thamesville is stated to produce 1,225 gallons of oil per day.

Dutton Field.

The Dutton oil field is situated in the township of Dunwich, Elgin County, near the shore of Lake Erie. In 1901 it contained 32 productive wells, usually about 435 ft. deep. The output of this field is from 35,000 to 38,500 gallons per month.

Tilsonberg Field.

The Tilsonberg oil wells are situated in the valley of Big Otter Creek in Oxford County. In 1901, when the field was opened, the production for the first well was 840 gallons a day. The second well sunk gave only 210 gallons a day, and this has now fallen to 52 gallons.

NOVA SCOTIA.

Petroleum has not yet been found in this Province in workable quantities, but there are indications of its existence at Cheverie, Hants County, and at Lake Ainslie, Cape Breton. At the latter place the oil rises to the surface and is found in the pools of the district. Several companies have at different times sunk wells at Lake Ainslie, but although indications of petroleum were observed no deposits have been found. An American expert, who made an examination of the district some years ago, came to the conclusion that the petroliferous area was so limited, and the dip of the strata so steep, that there was little probability of petroleum being obtained in quantity sufficient to pay for development. Since then the district has again been examined by experts, who have expressed the opinion that large deposits of oil exist, and it is probable that exploratory drilling will be continued, especially as natural gas has recently been found in some quantity.

Shales rich in bituminous matter are said to occur at Cape George, Antigonish County, and on the north side of East Bay, Cape Breton; the shales of the latter district are reported to yield from 15 to 20 gallons of oil per ton.

NEW BRUNSWICK.

A petroliferous formation, stated to run through this province from south-east to north-west, is now being exploited by the New Brunswick Petroleum Company. Several wells have been sunk, but the yield of oil obtained is small. One well at Memramcook, Westmoreland County, produced 58 gallons of oil per hour. The characteristics of the New Brunswick oil have been alluded to already.

The Albert shales at Baltimore were formerly mined and distilled; the best qualities yielded 63 gallons of oil per ton of shale. These operations, which were discontinued in the early days of the Canadian petroleum industry, are likely to be resumed in the near future.

QUEBEC.

The only petroleum district in this province is along the East Coast of the Gaspe Peninsula. The localities are on the St. John's River at Tar Point and near the Gaspe Basin. Trial borings have demonstrated the existence of oil at a considerable depth, but not in sufficient quantity to pay for working.

THE NORTH-WEST TERRITORIES.

The existence of petroleum is indicated over a very large area in the North-West Provinces of Canada. The formation known as the "tar sands," consisting of sandstone impregnated with inspissated petroleum, outcrops for 100 miles or more along the Athabasca River, appears again on the Peace River, and this or a corresponding petroleum-bearing formation is found far north on the Mackenzie River. The southern limit is probably in Saskatchewan, or it may even extend to Manitoba. The source of the bitumen found in this immense area is supposed to be the Devonian limestone, which apparently everywhere underlies the "tar sand" formation. This bituminous sand soften at about 75° Fahr. and contains the following ingredients:—

	Per cent.
Bitumen	12·42
Water (mechanically included) ...	5·85
Siliceous sand	81·73

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These "tar sands" have been formed by the upwelling of enormous quantities of petroleum in past times, and the loss of the more volatile hydrocarbons by volatilisation has left the bituminous residue.

The amount of bitumen "in sight" in the "tar sands" is estimated at about 4,700,000,000 tons.

It was formerly supposed that the petroleum had volatilised only at the outcrop, and that underneath the surface in the extension of the petroleum-bearing formation a more liquid oil would be found.

Experimental borings made by the Director of the Geological Survey of Canada to test the validity of this theory, owing to unforeseen obstacles, only reached the sands in one case, and in this the petroleum was in the semi-fluid condition of that at the outcrop. Enormous reservoirs of gas were, however, shown to exist.

Liquid petroleum occurs in small pools on the northern side of the Great Slave Lake. A sample recently taken on the Athabasca River showed that this was a fine quality of petroleum with a paraffin base.

Oil is reported to have been found near Calgary, Alberta, at a depth of 1,020 feet, and the flow is said to be considerable.

BRITISH COLUMBIA.

Petroleum occurs as surface pools in several localities in South and East Kootenay, B.C., but so far no trial bores have been made.

NEWFOUNDLAND.

There is an area of petroleum-bearing territory, probably 250 square miles in extent, occupying the west coast of the island between the sea and the range of mountains running parallel to it.

Four wells were drilled at Port-a-Port in 1898; three of these reached small oil pools at depths of from 136 to 684 feet. The shallow well is said to have produced 350 gallons of oil per day during the first month. The oil is dark brown and is said to have good lubricating qualities.

Three productive wells have been bored in the vicinity of Parson's Pond. One of these, when first opened, is stated to have yielded 630 gallons of oil during the first hour. Preparations were being made in 1900 by the company concerned to carry out extensive boring operations in this district.

Bulletin of the Imperial Institute.

MANURIAL EXPERIMENTS IN FLAX CULTIVATION.

Although much scientific work has been done in recent years in order to improve the methods of agriculture as applied to the cultivation of food stuffs, comparatively little has so far been done in the same direction to improve plants yielding industrial products. The methods by which these products are formed and the purposes they subserve in the plant are in many cases still unknown, so that it is difficult without long continued field experiments to make suggestions as to the method of cultivation likely to yield better results. The observations recorded below with regard to results of manurial experiments carried out with flax plants are of particular interest, not only in connection with the Irish flax industry, but also as regards the very similar problems presented by the numerous plantations of fibre plants now established in many Colonies.

The fibre of the flax plant, *Linum usitatissimum*, is the material from which linen is spun and woven, and its seed is the well-known linseed, used as a source of oil and cattle food. In preparing "scutched flax," the raw material of the linen manufacture, the crop goes through a number of operations. The plant, which grows to a height of 20 to 40 inches, is harvested by being pulled up from the soil; it is then "rippled," that is, the capsules containing the seeds are removed by dragging the plant through a comb. The stalks are next made into bundles and "retted," that is, soaked in water for 10 to 14 days; during this treatment a process of fermentation goes on, which dissolves the glutinous matter and renders it possible to separate the fibre. The stalks are next "grassed," that is, spread on grass for a week or fortnight; they are then passed between the grooved rollers of the "breaking" machine, which break up the woody core of the stem. This woody core is then removed by the "scutching" mill. In this a set of flat wooden blades are fixed to the circumference of a small wheel so that the wheel and blades are in the same plane. This wheel revolves vertically so that the blades pass close alongside an upright partition. One end of a bundle of stalks is pushed through a slot in the partition, so that the stalks hang down for half their length, and get well beaten by the edges of the blades as the wheel revolves. When the pieces of woody core are knocked out the other half is similarly treated, and the product is "scutched flax." A certain amount of waste fibre is produced at the same time, and is known as scutching tow.

The Department of Agriculture and Technical Instruction for Ireland has published several papers on this important industry; they deal with the history of the subject, and also

Manurial Experiments in Flax Cultivation.

embody the results of a series of experiments which the Department has commenced on the manuring of the crop, on the selection of the seed, and on the preparation of the flax for the market; there are also added the reports of some experts and millowners, who visited the Continental flax districts in order to compare the processes in vogue there with those employed in Ireland. These papers are to be found in the June number of the Journal of the Department of Agriculture and Technical Instruction for Ireland for 1903, vol. 3, pp. 663 *et seq.*; and in the volume for 1902, vol. 2, pp. 636 *et seq.*

HISTORY.

That flax was cultivated and manufactured in Ireland in an age long before the Christian era is shown by references to it in the Brehon law, the recognised ancient Irish code. In more modern times the industry received frequent attention and encouragement from the Government and from various public bodies. Reliable information on the subject dates from the Lord Lieutenantcy of Strafford, 1633 to 1640; he imported seed from Holland and brought over Dutch instructors to teach the best methods of flax cultivation.

The revocation of the Edict of Nantes at the end of the 17th Century brought about the settlement of a large number of Huguenots in Ulster, who improved and developed the industry and established the linen manufacture on an extended scale. Since then flax growing has held an important place among Irish industries, although it has passed through many vicissitudes. As it increased in importance, it soon began to experience the effect of active competition from the linen manufacturers of Belgium and France, who for centuries had supplied the markets of the world; and if the Government had not come to the assistance of the industry in its early stages the struggle for existence would have been long and difficult.

In 1711 a Board of Trustees was appointed to manage the funds arising from certain duties set aside by two Acts of Parliament for promoting the growth of flax in Ireland, and the improvement of the manufacture of linen and hemp. This Board continued in existence until 1828, when it was dissolved. The existing records of the area under flax go back to 1812; from that date to 1825 the average annual acreage under flax amounted to 132,000 acres, or nearly three times the extent to which it is cultivated at the present day.

The next body devoted to the encouragement of the industry was the Flax Improvement Society, afterwards known as the Royal Society, founded in 1841. This Society succeeded in bringing the flax-growing industry to a state of perfection that has not since been equalled. In 1852 there were 137,008 acres

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under flax, and the yield per acre was 41·43 stones, which is the highest yield recorded in the history of the Irish industry. In 1853 there were 174,579 acres under flax, and the yield per acre was 40·21 stones. In 1859 the work of this Society came to an end.

During the next ten years, 1860 to 1869, the area under flax reached its maximum, but the average annual yield of scutched flax per acre was only 25·84 stones. This was partly caused by a series of adverse seasons. In this period the average acreage under flax was 214,624. The maximum occurred in 1864, when the acreage was 301,693, and the yield per acre 34·43 stones. The civil war in the United States caused an almost complete cessation in the supply of raw cotton, with the result that linen came into demand at greatly enhanced prices; the average annual price per stone reaching 10*s.* 10½*d.* in 1866, and being for the ten years 9*s.* 1½*d.*

The area under flax declined, until in 1898 it was only 34,489 acres, the smallest on record since 1812. In the following years, 1899 to 1902, there has been a slight increase in the area under flax, and a marked improvement in the yield of scutched flax per acre.

The Department of Agriculture and Technical Instruction for Ireland, which dates from 1st April, 1900, at once directed its attention to the flax industry, and the following is a short account of the results of the experiments and investigations conducted by it.

MANURIAL EXPERIMENTS.

Flax is unique among British crops in that the valuable part of the crop is neither the seed nor the nutritive components of the plant, but the fibre; it is the cell-walls themselves and not cell contents, such as starch and sugar, that are desired; hence the object in view is so entirely different from that in the case of other farm crops that the numerous results of experimental investigations on the manuring of the latter afford but little guidance as to the best procedure for flax cultivation.

The manuring that increases the bulk of the straw in other crops does not necessarily benefit the flax crop, as increased bulk of flax straw is of no advantage unless it is accompanied by a high percentage of fibre, and this also of good quality. A bulky crop which yields a high percentage of scutched flax, but of inferior quality, may give a lower monetary return than a much lighter crop which yields a better quality of scutched flax. The quality of the product is therefore a very important factor in considering the results of experiments on this crop.

Enquiries showed that comparatively little reliable information on the subject was available either in this country or on the Continent, so the Department decided to conduct a series of experiments themselves; these they commenced in 1901 and continued in 1902.

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In the first of these years the trials were carried out on seven farms in the north of Ireland; five kinds of manurial treatment were tried, and one plot on each farm received no manure so as to afford a basis of comparison. By increase or decrease in the following account is meant increase or decrease as compared with the corresponding unmanured plots.

The plots were arranged thus (the quantities mentioned being the dressings per acre):—

1. No manure.
2. Superphosphate, 5 cwts.
3. Kainit, 5 cwts.
4. Muriate of potash, 1 cwt.
5. Superphosphate, 3 cwts.; kainit, 3 cwts.
6. Superphosphate, 3 cwts.; kainit, 3 cwts.; sulphate of ammonia, ½ cwt.

The experiments were continued in 1902 with some additions and modifications suggested by the results of 1901. Three extra plots were added on which the effects of salt, of rape meal, and of basic slag were tried, and as the potassic manures had yielded a profit in 1901, heavier dressings of these were applied to see if they would thus prove even more valuable.

The plots were arranged thus:—

1. No manure.
2. Kainit, 6 cwts.
3. Muriate of potash, 1¼ cwts.
4. Salt, 4 cwts.
5. Superphosphate, 3 cwts.; kainit, 3 cwts.
6. Superphosphate, 3 cwts; kainit, 3 cwts.; sulphate of ammonia, ½ cwt.
7. Rape meal, 5 cwts.
8. Basic slag, 5 cwts.

The experiments were conducted on seven farms which were, however, not the same as those on which the 1901 experiments were made. The plots were each one-tenth of an acre, and the plan of manuring was the same at each farm. The quantity of seed sown was at the rate of 62 quarts per acre. Compared with 1901 the season was very unfavourable for the growth of flax, chiefly owing to the lack of sunshine; the summer was much wetter in many centres than the season of 1901, and was remarkable for the large number of days on which rain fell. As regards the appearance of the growing crops it was observed that the muriate of potash plot looked best, and the

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kainit plot second best. All the plots except those to which potassic manures were applied were slightly yellowed. Wherever superphosphate had been applied the growth of a large number of weeds was encouraged, particularly charlock and spurry.

The Unmanured Plots.

In 1901 the plots to which no manure had been applied yielded on the average 3,374 lbs. of retted straw per acre, and 40 stones 5 lbs. of scutched flax (being 16·72 per cent. of the retted straw); this was valued at 8s. per stone, making 16*l.* 2*s.* 8*d.* per acre. In this year's experiments the tow was not valued. Considering individual farms, the maximum yield of scutched flax was 55 stones 5 lbs. per acre, and the minimum was 27 stones 2 lbs.

In 1902 the similar plots yielded on the average 3,211 lbs. of retted straw per acre and 36 stones 5 lbs. of scutched flax (being 15·85 per cent. of the retted straw); this was valued at 7*s.* 7*d.* per stone, and there was an average return of 17*s.* 1*d.* per acre from the tow, making in all 14*l.* 17*s.* 3*d.* per acre. Considering individual farms the maximum yield of scutched flax was 52 stones 12 lbs. per acre, and the minimum was 20 stones.

Effect of Superphosphate alone.

In 1901 the plots to which superphosphate alone had been applied yielded on the average 3,449 lbs. of retted straw per acre, an increase of 75 lbs. above the yield of the unmanured plots; yet the average yield of scutched flax was reduced, being 37 stones 12 lbs., a decrease of 2 stones 7 lbs. The scutched flax was 15·38 per cent. of the retted straw (1·34 per cent. lower), and its quality was poorer, as it was valued at only 7*s.* 8*d.* per stone, making 14*l.* 11*s.* 7*d.* per acre. The manure cost 11*s.* 10*d.* per acre, consequently this manuring caused an average monetary decrease of 2*l.* 2*s.* 11*d.* per acre as compared with the unmanured plots. On two farms, however, the superphosphate caused an increase in the yield of scutched flax and left a profit. This seems to show that on certain soils deficient in available phosphates an application of superphosphate will produce profitable results. Another effect of the superphosphate was that on foul land it encouraged the growth of weeds, especially cruciferous weeds, such as charlock, which must have been detrimental both by reducing the quantity of available plant food and discolouring the flax fibre while in the retting pond.

In 1902 superphosphate alone was not tried.

Effect of a Mixture of Superphosphate and Kainit.

This mixture supplies both phosphorus and potassium to the crop. In 1901 the plots to which it was applied yielded on the

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average 3,619 lbs. of retted straw per acre, an increase of 245 lbs.; yet the average yield of scutched flax was reduced, being 38 stones 13 lbs., a decrease of 1 stone 6 lbs. The scutched flax was only 15·04 *per cent.* of the retted straw (1·68 per cent. lower); it was valued at 7*s.* 10*d.* per stone, making 15*l.* 7*s.* 8*d.* per acre. The manure cost 14*s.* 7*d.* per acre. The average returns show a great similarity to those of the superphosphate plots, but the monetary decrease per acre as compared with the unmanured plot was not so heavy, being 1*l.* 9*s.* 7*d.* This advantage was very possibly due to the kainit. On two of the farms the application of this mixture showed a profit.

In 1902 the plots thus treated yielded on the average 3,214 lbs. of retted straw per acre, that is practically the same yield as the unmanured plots; the yield of scutched flax was 35 stones 8 lbs., a decrease of 11 lbs. The scutched flax was 15·49 per cent. of the retted straw (0·36 per cent. lower); it was valued at 7*s.* 8*d.* per stone., and the tow at 17*s.* 2*d.* per acre, making 14*l.* 9*s.* 9½*d.* per acre. The manure cost 17*s.* 1*d.*, and there was a monetary decrease of 1*l.* 4*s.* 6½*d.* Considering the various farms separately, there was an increase of scutched flax in three cases; and in one of these it was as much as 11 stones 6 lbs. It was noticeable that at this farm kainit alone produced an increase of 5 stones, and basic slag alone (a phosphatic manure) an increase of 6 stones 6 lbs., so it was evidently a soil that responded to the application of these manures.

Effect of a Mixture of Superphosphate, Kainit and Sulphate of Ammonia.

This mixture is practically a complete manure, as it supplies nitrogen, phosphorus and potassium, the only three elements ordinarily considered of value in purchased manures.

In 1901 the plots thus treated yielded on the average 3,535 lbs. of retted straw per acre, an increase of 161 lbs.; yet the average yield of scutched flax was reduced, being 38 stones 2 lbs., a decrease of 2 stones 3 lbs. The scutched flax was 15·11 per cent. of the retted straw (1·61 per cent. lower); and it was valued at 7*s.* 10*d.* per stone, making 15*l.* 0*s.* 7*d.* per acre. This manuring was the most expensive of all the applications, costing 1*l.* 0*s.* 7*d.* per acre, and the monetary decrease per acre was 2*l.* 2*s.* 8*d.* On foul land the growth of weeds was encouraged. One important inference to be drawn from these results is, that while manures may increase the quantity of straw, it does not necessarily follow that the quantity of fibre is also increased.

In 1902 the plots thus treated yielded on the average 3,406 lbs. of retted straw per acre, an increase of 195 lbs.; the yield of scutched flax was 34 stones 3 lbs., a decrease of 2 stones 2 lbs., thus confirming the inference drawn from the previous year's results. The scutched flax was 14·06 per cent. of the

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retted straw (1·79 per cent. lower); it was valued at 7*s.* 7*d.* per stone, and the tow at 18*s.* 0¾*d.* per acre, making 13*l.* 18*s.* 2¼*d*,. per acre. The manure cost 1*l.* 3*s.* 0¾*d.*, and there was a monetary decrease of 2*l.* 2*s.* 1½*d.*

Effect of Kainit.

The valuable part of this manure is the potassium which it supplies to the soil and crop; in addition to potassium sulphate it contains magnesium sulphate, magnesium chloride, and common salt.

In 1901 the plots to which it was applied yielded on the average 3,699 lbs. of retted straw per acre, an increase of 325 lbs.; and 43 stones 7 lbs. of scutched flax, an increase of 3 stones 2 lbs. The scutched flax was 16·44 per cent. of the retted straw, which is approximately the same as in the case of the unmanured plots, and it was valued at 7*s.* 11*d.* per stone, which is 1*d.* lower than that of the unmanured plots, making 17*l.* 4*s.* 5*d.* per acre. The manure cost 12*s.* 6*d.* per acre, and thus there was a net monetary increase of 9*s.* 3*d.* per acre.

It thus appears as if potassium was the proper manurial element for increasing the yield of fibre; this view is further supported by comparing the average yield of scutched flax (38 stones 13 lbs.), from superphosphate and kainit, together with that from superphosphate alone (37 stones 12 lbs.), the increase of 1 stone 1 lb. being doubtless due to the kainit.

In 1902 the dressing of kainit was raised to 6 cwts.; the plots so treated yielded on the average 3,326 lbs. of retted straw per acre, an increase of 115 lbs.; and the yield of scutched flax was 36 stones 5 lbs., exactly equal to the yield of the unmanured plots. The scutched flax was 15·30 per cent. of the retted straw (0·55 per cent. lower); it was valued at 7*s.* 7*d.* per stone, and the tow at 17*s.* 3*d.* per acre, making 14*l.* 16*s.* per acre. The manure cost 15*s.*, and there was a monetary decrease of 16*s.* 3*d.* per acre. Considering individual farms, there was an increase in the yield of scutched flax at four out of the seven farms, but the average results showed a monetary decrease, in contradiction to the results of the previous year. This was doubtless due to the unfavourable season; and, further, the kainit was applied at the time the seed was sown, and might have yielded better results if it had been applied several weeks earlier, or even in the previous autumn. On the Continent it has been found that the direct application of kainit to potatoes or sugar beet diminishes the yield of starch and sugar respectively, but that the residue from its application to the previous crop produces increased yields and profitable returns.

Effect of Muriate of Potash.

This manure is much more concentrated than kainit, as it contains 48 per cent. of potassium, equivalent to 58 per cent.

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of potash, whilst kainit contains only 10 per cent. of potassium or 12 per cent. of potash.

In 1901 the plots to which it was applied (it was only tried on four of the farms) yielded on the average 3,942 lbs. of retted straw per acre, as against 3,659 lbs. on the unmanured plots of the same four farms, an increase of 283 lbs.; the yield of scutched flax was 49 stones 4 lbs., as against 44 stones 2 lbs., an increase of 5 stones 2 lbs. The scutched flax was 17·51 per cent. of the retted straw and was valued at 8*s.* per stone, making 19*l.* 11*s.* 2*d.* per acre. The manure cost 12*s.*, and there was a monetary increase of 1*l.* 6*s.* per acre. There was a substantial increase of scutched flax on all the four farms, and it was noticed that the potassic manures did not encourage the growth of weeds to the same extent as superphosphate and sulphate of ammonia; in fact, they appeared to check their development, especially when kainit was used. In addition to this there was an almost entire absence of "yellowing" where potassium had been supplied.

These results confirm those observed on the kainit plots and show that muriate of potash is even better than kainit.

In 1902 the dressing of muriate of potash was raised to 1¼ cwts., so as to contain about the same quantity of potassium as the 6 cwts. of kainit. The plots thus treated yielded on the average 3,169 lbs. of retted straw per acre, a decrease of 42 lbs., and the yield of scutched flax was 37 stones 1 lb., an increase of 10 lbs. The scutched flax was 16·38 per cent. of the retted straw (0·53 per cent. higher); it was valued at 7*s.* 9*d.* per stone and the tow at 14*s* 5*d.* per acre, making 15*l.* 5*s.* 7*d.* per acre. The cost of the manure was 12*s.* 6*d.*, and there was a monetary decrease of 4*s.* 2*d.* per acre.

Thus, although the average yield of retted straw per acre was decreased, the percentage of scutched flax to retted straw was so much greater that the yield of scutched flax was also larger. In both years with the muriate of potash manuring this percentage was greater than with any other, and the quality of the flax was not surpassed. Considering individual farms, there was an increase in the yield of scutched flax at four farms, amounting in one case to 7 stones 12 lbs., which produced a monetary increase of 2*l.* 9*s.* per acre after allowing for the cost of the manure. These results confirm those of 1901, namely, that muriate of potash is the most effective manure for flax.

Effect of Salt.

As the application of kainit in 1901 proved very profitable, and as it usually contains about 33 per cent. of common salt, the effect of common salt alone was tried in the 1902 experi-

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ments to see whether the beneficial action of kainit was due to the potassium or to the common salt.

The plots thus treated yielded on the average 2,951 lbs. of retted straw per acre, a decrease of 260 lbs.; and the yield of scutched flax was 33 stones 10 lbs., a decrease of 2 stones 9 lbs. The scutched flax was 15·99 per cent. of the retted straw (only 0·14 per cent. higher); it was valued at 7*s.* 7*d.* per stone, and the tow at 14*s.* 8½*d.* per acre, making 13*l.* 12*s.* 9½*d.* per acre. The manure cost 4*s.* 9½*d.*, and there was a monetary decrease of 1*l* 9*s.* 3*d.* Considering individual farms, at only two was there a rise in the yield of scutched flax. On comparing these results with those from the kainit plots, it is evident that it is the potassium and not the common salt that is the effective manurial agent.

Effect of Rape Meal.

In order to try the effect of a slow-acting nitrogenous manure, in 1902 rape meal plots were added to the scheme. They yielded on the average 3,300 lbs. of retted straw per acre, an increase of 89 lbs., and the yield of scutched flax was 31 stones 5 lbs., a decrease of 5 stones. The percentage of scutched flax to retted straw was very low, being only 13·30 per cent. (2·55 per cent. lower); it was valued at 7*s.* 6*d.* per stone, the lowest of all the valuations; the tow was valued at 18*s.* 6*d.* per acre, making 12*l.* 15*s.* 11*d.* per acre. The manure cost 1*l.* 7*s.* 6*d.*, and the monetary decrease was 3*l.* 8*s.* 10*d.*

The results of applying this manure were thus very unpromising; but the cold, wet season of 1902 was not at all favourable to a slow-acting manure such as rape meal, and it is possible that an earlier application of it, or a more propitious season, would have shown it to give more beneficial results.

Effect of Basic Slag.

Basic slag is a phosphatic manure containing a calcium phosphate, but not in such a readily soluble form as the one in superphosphate.

In 1902 the plots to which it was applied yielded on the average 3,144 lbs. of retted straw per acre, a decrease of 67 lbs., and 32 stones 8 lbs. of scutched flax, a decrease of 3 stones 11 lbs. The scutched flax was 14·50 per cent. of the retted straw (1·35 per cent. lower); it was valued at 7*s.* 9*d.* per stone, and the tow was valued at 17*s.* 4½*d.* per acre, making 13*l.* 11*s.* 9½*d.* per acre. The cost of the manure was 13*s.* 1½*d.*, and there was a monetary decrease of 1*l.* 18*s.* 7*d.* per acre.

Thus in every case there was a falling off from the average yields of the unmanured plots, except in the quality of the flax, which was valued at 2*d.* more per stone; but this did not nearly make up for the other deficiencies. Experience with other crops has shown that basic slag usually gives the best returns when applied in the previous autumn.

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Summary.

In drawing conclusions from these results it must be remembered that they represent the experiments of only two seasons, and that manurial trials in the case of other crops have to be conducted for many years before the effect of various applications can be determined with certainty. The Department has accordingly been continuing the experiments during 1903.

The most striking result arrived at is the effect of potassic manures in producing flax fibre, muriate of potash surpassing kainit in this respect. In the average results the other manures appear to have diminished the monetary returns; but in individual cases they often proved beneficial; thus the farmer must consider the peculiarities of his own land in deciding as to their use. For the most part the farmers who were willing to undertake the experiments had land capable of producing good crops for one year without the application of manures, and this accounts for the good average yields of the unmanured plots. The apparent injurious effect of superphosphate and sulphate of ammonia is very probably rather to be attributed to their favouring the growth of weeds, which abstract from the soil some of the available plant food, than to a directly injurious action of the manure on the flax plant. The flax crop, owing to its small development of leaf, undoubtedly affords facilities for the growth of weeds.

VARIETIES OF SEED.

The second section of the investigation dealt with the question of the best kind of seed to sow. In 1901 four varieties of seed were tested. Two of these, namely, Riga seed (Belfast brand) and Dutch seed (Belfast brand) were selected as representing the seeds usually sown by Irish growers; they are of foreign origin. As the Continental growers purchase better varieties than the Irish, two such varieties were procured and tested, namely, Riga seed (Pernau Crown) and Dutch seed (Riga Child); the latter is obtained from flax grown in Holland from Riga seed. The experiments were conducted on five farms, and it was found in the average results that both Riga Child and Pernau Crown seeds gave larger yields of scutched flax than either of the Belfast brands of seeds, and that the Pernau Crown seed gave the largest yield and the greatest monetary return; the varieties, however, did not always show the same order of merit at different farms.

A sample of Irish-grown seed was sown at two farms, but the poor yields obtained seem to indicate that it is useless in Ireland to attempt to save flax seed for sowing; such a practice, especially in a wet season, might lead to the loss of both straw and seed.

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These experiments were continued in 1902 with the same four varieties of seed. In this year the two Russian seeds, Riga seed (Pernau Crown) and Riga seed (Belfast brand) showed in the average results the best yields of scutched flax and the highest monetary returns, the Pernau Crown variety being again the best of all.

There is already a marked improvement in the quality of seed imported into Ireland, and the Department strongly condemns the use of inferior seed for sowing, even though it be cheaper. The difference between crops from good and bad seed is many times greater than the difference in the price of the seed. At the Department's seed-testing station a report on the quality and germinating power of the seed can be obtained for 3*d*.

RIPPLING.

At first sight it would appear that the Irish practice of omitting the rippling process involves an enormous waste, as the linseed from 40,000 acres of flax is completely lost; but when the climatic conditions of Ireland are considered, the omission appears more excusable. Rippling not only requires more labour, which is difficult to obtain, but by lengthening the period between pulling and placing the stalks in the retting pond exposes the flax to suffering deterioration by rainy weather.

In 1902 the Department made a comparative trial; rippling one-half of the crop from an acre and retting the other half at once. The pulling of the half acre to be rippled was started two days earlier than in the case of the other half in order to have the stalks from both halves ready for the retting pond at the same time. Owing, however, to heavy rains the rippled stalks were not ready for retting until two days after the non-rippled.

The rippling was found to have reduced the weight of scutched flax and to have deteriorated its quality, and the value of the linseed recovered was not sufficient to make up for the cost of extra labour, together with the losses incurred, so that there was a net monetary decrease of 12*s*. 7*d*., or 1*l*. 5*s*. 7*d*. per acre.

This is only an isolated experiment, but it shows how the weather conditions affect the question.

SCUTCHING TRIALS.

As Irish flax does not command such high prices with the Irish spinners as Belgian flax, the department determined to discover the causes of the difference. Investigation into the systems practised at Courtrai showed that the superiority of the Belgian flax was due to a number of circumstances. Compared with Ireland, the flax lands in Belgium are more uniform, the climate is better, the conditions for retting are more favourable, the soil is better prepared, labour is more efficient

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and cheaper, and more care is bestowed on the handling of the flax. Much of the difference is thus due to natural advantages; but it seemed very possible that the Courtrai method of scutching might be tried in Ireland with prospects of yielding a greater profit than the Irish method. The department, therefore, decided to undertake a series of trials on a scale that would yield results leaving no room for indecision.

The first series of trials was designed to compare the work of the Irish mills with that of one of exactly the same pattern as those used in Belgium. This mill was imported from Courtrai and was a six-blade scutch mill, and a staff of six Belgian scutchers and one boy was engaged to work it. Twenty complete trials were made between this mill and 20 Irish mills; a stack of straw being equally divided between the Belgian mill and one of the Irish mills for each trial. The average of the result of the 20 trials showed that as regards profit the Irish mills had the advantage; for although the quality of the scutched flax from the Belgian mill (it was valued at 7*s.* 3*d.* per stone) was much superior to that from the Irish mills, which was valued at 6*s.* 7*d.* per stone; yet the greater yield of scutched flax from the Irish mills, being 17·91 per cent. of the straw as against 15·39 per cent. from the Belgian mill, more than made up for the inferior quality of the former. The average cost of scutching per stone in the Irish mills was only 1*s.* 1¼*d.* as against 2*s.* 3*d.* in the Belgian mill, and this further enhanced the profit from the Irish mill. The net advantage in favour of the Irish mills was 1*l.* 14*s.* 5*d.* per ton of straw. Having thus proved that with *Irish flax straw* the Irish mill affords greater profit than the Courtrai mill, although the scutched flax is of lower quality, the department in the next session decided to compare the Irish mills and Belgian mills when operating on *Belgian flax straw.*

The Courtrai retting is much more thorough than that practised in Ireland, so it seemed possible that the observed superiority of the Irish mills might be due to the fact that the Irish flax straw was not sufficiently retted to show the Courtrai mill at its best. Accordingly some retted Belgian straw was purchased at Courtrai and part of it was scutched there and the rest was sent to Ireland and treated in the Irish mills. It was found that the Irish mills again yielded a higher proportion of scutched flax than the mill in Belgium. The average was 23·26 parts of scutched flax from 100 parts of retted straw in the Irish mills as against 21·96 parts in the mill in Belgium. On the other hand the average value of the Irish product was only 9*s.* 0¾*d.* per stone as against 11*s.* 7½*d.* per stone for the Belgian scutched flax, and further, the tow from the Belgian mill was much more valuable, 35*s.* worth

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being obtained per ton of straw as against 3*s*. 10*d*. worth at the Irish mills. As regards profit, the result was a reverse of the previous one; for now the mill in Belgium, although the cost of scutching a ton of straw was 3*l*. 19*s*. 4*d*. as against 2*l*. 8*s*. 10*d*., the average of the cost in the Irish mills gave a net return of 18*l*. 4*s*. 2*d*. per ton of straw as against 14*l*. 12*s*. 7*d*. the average net return in Ireland. This net return is the value of the scutched flax and tow from a ton of straw less the cost of scutching.

The chief point of difference between the Belgian and the Irish mills is in the weight of the blades, those of the Courtrai mills being much lighter. Another series of trials was therefore made to try the effect of enlarging the blades of the imported Courtrai mill to a size intermediate in weight between those commonly used in Courtrai and those commonly used in Ireland. The results were very encouraging, as it was found that the modified Courtrai mill working in Ireland on Irish straw now yielded slightly more scutched flax than the Irish mills working with exactly the same straw, the averages being 16·62 parts and 16·37 parts respectively of scutched flax from 100 parts of straw. In addition to this the quality of the product from the modified mill was much superior to that from the Irish mills, the valuation being 8*s*. 0¾*d*. per stone as against 6*s* 8½*d*. The tow produced was also more valuable. The cost of scutching was estimated at 2*s*. per stone in the modified mill and 1*s*. 3*d*. in the Irish mills. The net return was distinctly in favour of the former, being 8*l*. 15*s*. 1*d*. as against 7*l*. 13*s*. 8*d*. per ton of straw scutched.

In these trials the modified Courtrai mill was worked by Belgians. In the next season it is proposed to test the modified Courtrai mill when worked by Irishmen against the Irish mills.

The results are briefly summarised thus:—

(1.) With Irish retted straw Irish mills, in the hands of Irish workers, give better pecuniary returns than does a Courtrai mill in the hands of Courtrai scutchers.

(2.) With Belgian retted straw the reverse holds good, *i.e.*, the Courtrai mill gives the better returns.

(3.) With straw retted in Ireland by the usual method, the Courtrai mill, worked by Belgians, and fitted with modified blades, yields more profitable returns than does the Irish mill worked by Irishmen, or the unmodified Courtrai mill worked by Belgians.

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SISAL HEMP INDUSTRY IN MEXICO.

Sisal hemp, or Henequen hemp, is a fibre of considerable industrial importance, derived from the leaves of *Agave rigida*, and probably also from those of other species.

The name "Sisal" was applied to the fibre since it was originally exported from the town of that name, which is situated at a distance of 35 miles from Merida, the capital of the State, and the great centre of the Yucatan fibre market. Until the year 1871, Sisal was the only port of entry in Yucatan, but has since been superseded by Progreso.

There are two varieties of the cultivated Sisal plant, the "Yaxci" (*Agave rigida* var. *sisalana*), or "green fibre," and the "Sacci" (*A. rigida* var. *elongata*), or "white fibre;" the latter is the more widely cultivated and yields most of the Sisal hemp of commerce.

The first attempt to produce the fibre on a commercial scale was made in 1839. It was already known that the spiny-edged Agave, termed "Sacci," yielded a fibre which, although coarser than that of the "Yaxci," was much more abundant and consequently more profitable to cultivate. The fibre was cleaned by means of native instruments, and was afterwards packed in loose bales of about 200 lbs. each and sent to New York. It found a market, but was little remunerative. The methods of cleaning the fibre were so slow that, even with the cheap labour of that time, the cost of production was discouraging. The State Government, recognising the great need of a suitable machine to clean the fibre, offered a prize of 10,000 Mex. dols. to the inventor of an apparatus capable of producing a certain output per hour. The result of this offer was the invention of the "Raspador" machine by a Franciscan friar.

It is usually supposed that the "Sacci" plant thrives best in a thin, rocky, limestone soil. Experience indicates that the fibre grown upon soil of this class has a greater tensile strength than that produced on richer land, although in the latter case the fibre is longer and more flexible. Contrary to the general opinion, a poor, sandy soil is not congenial to the growth of a large, full-sized fibre plant.

It is not adversely affected by hot seasons; in fact, the heat of the sun, especially when accompanied by humidity, appears to act beneficially. The development of the plant may be delayed and the quality of its fibre impaired by a protracted drought, but the growth of a healthy well-rooted plant cannot be stopped thereby. Rainy seasons do not seriously injure the plant, and it is not seriously affected by cold.

The plant can be propagated by means of seed, cuttings, and suckers or scions. The first-mentioned method is now never

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practised, since very few of the seeds are fertile and much time is lost in raising the seedlings. Propagation by mean of cuttings is sometimes adopted, but the more general method of cultivation is as follows. About a month or so before the rainy season the "hijos" or suckers of the Sisal plant, which have sprouted under the shelter of the parent plant and are about 18 to 20 inches high, are uprooted and thrown into heaps where they are allowed to remain for two or three months exposed to the sun and weather. Just before the rainy season commences, the young suckers, which now appear dried up and decayed, are planted out in rows. At one time the young plants were planted at a distance of 2 yards from one another, but recently it has been found advantageous to space them in such a way that they form lines 4 yards apart, each plant being separated from its neighbour by a distance of 1½ yards. This arrangement gives about 1,100 plants to the acre.

After the suckers have been planted, no special care or irrigation is required, but once or twice a season the fields are roughly weeded. The plant thrives, and in the course of five years the older leaves begin to extend themselves laterally at right angles to the trunk of the plant. The fibre has now reached its highest tensile strength and the leaves are ready to be cut. Harvesting is effected by means of a knife with a hooked end which is termed the "corba" or "machete," and weighs about 1½ lbs. The native cutters throng the field and with their "corbas" deftly cut the leaves close to the trunks, trim off each line of side thorns at a single stroke, snip off the horny end, and bind the leaves in bundles. These bundles are then conveyed by tramcar to the cleaning machine.

An interesting account of the preparation of Sisal hemp has recently been given by the United States Consul at Progreso, in which it is stated that the extraction of the fibre is accomplished both by the primitive native implements, the "paeche" and "tonkas," and also by machinery. The "paeche" is a long, wooden bar, triangular in section, with sharpened edges, and provided with rounded ends which serve as handles. The end of a leaf is fixed by means of a peg into a hole on the flattened surface of a log of wood; the "paeche" is then pushed away from the operator over the surface of the leaf, and by this scraping process the pulp is gradually removed from the fibre. The "tonkas" is a hard, wooden knife about 18 inches long and 5 inches wide. At its upper edge it is about an inch thick, but it gradually becomes thinner, the lower edge being thin and sharp and curving inwards. The fixed table has a curved surface corresponding to that of the edge of the instrument. The leaf is placed between the table and the "tonkas," and the latter is held firmly with one hand whilst with the

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other hand the leaf is drawn sharply towards the operator. The "paeche" is the implement most in use at the present time among the natives of the interior of Yucatan, and by its means one worker can produce from 6 to 9 lbs. of fibre per day. It is said that the fibre prepared in this primitive manner possesses qualities which are not present in the machine-cleaned product, and that the makers of the finest hammocks in Yucatan will not use a fibre prepared by any other method.

The invention of the "Raspador" machine inaugurated a new era in the commerce of Yucatan. It was found that with the aid of this machine two men could clean more fibre than forty could with the "paeche" and "tonkas," and, in consequence, Henequen farms began to multiply and become prosperous. The following table gives particulars of the machines at present in use in the Yucatan plantations:—

Machine.	Number of Leaves cleaned in 10 hours	Number of Men needed.	Actual Horse-power.	Cost of Machine.	
				Mexican.	British.
				Dollars.	£
Lanaux (improved) ...	150,000	4	25	7,000	620
Prieto (improved)... ...	150,000	4	16	8,600	760
Torrella (improved) ...	150,000	1	16	7,000	620
Villamor (improved) ...	100,000	7	16	5,000	110
Stephens	150,000	3	70	No more being made.	
Solis	9,000	3	9	2,000	180

It sometimes happens that a whole field of Sisal plants is destroyed by fire. This is an accident which must be carefully guarded against, and is liable to occur if a spark is allowed to fall on an ill-cleaned field. The resulting conflagration of the dry vegetable rubbish is fatally injurious to the roots of the plant.

Another danger to which the plant is liable is that of attack by a large black beetle known to the natives as the "max." The female insect lays its eggs on the trunk of the Sisal plant at a point a few inches above the ground. When hatched, the larva bores through the outer bark into the harder fibre of the interior, and, generally taking an upward direction, burrows from 6 to 12 inches. When fully grown, it works its way to the bark, where it changes to a pupa, and so remains for some months. Finally, the beetle emerges, leaving the plant injured and weakened, but rarely killed.

Serious consideration has been given recently to the careful selection of Sisal plants. Many plantations are stocked with fibre-producing plants of a high order, whilst others are handi-

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capped by plants producing a meagre fibre, although the quality of the soil seems to be the same in both cases.

Previous to the year 1889, little or no attempt was made to grade the hemp, but it is now found that a fine, white fibre, well cleaned and baled, can command a much better price than mixed fibre, ill-cleaned and badly baled.

The average annual output of Sisal fibre in Yucatan during the ten years ending 31st December, 1901, was 416,328 bales, each bale weighing approximately 400 lbs., and worth at the present time about 7*l*. The output for the year ending 30th June, 1902, amounted to 564,308 bales, of total weight 90,005 tons, and of the total value of 2,624,038*l*.

SERICICULTURE IN CEYLON.

The attention of the Government of Ceylon has of late years been drawn to the possibility of establishing sericiculture as a native industry. In the "Ceylon Administration Reports for 1900," the Government entomologist, Mr. E. Ernest Green, stated that a correspondence had taken place between the Ceylon Government and a company desirous of starting silk-growing in the island, but that unfortunately the negotiations had broken down. He is of opinion, however, that this industry, if once properly started, would be of great benefit to the native population, since the rearing of silkworms could be easily learnt by the Sinhalese and could be carried on in addition to their usual occupations. The cocoons should be sold to central factories.

There is evidence that attempts were made to establish sericiculture in Ceylon at a comparatively early period, but the industry does not seem to have developed to any great extent. Previous to the arrival of the Dutch, experiments in this direction had been made by the Portuguese, and a strip of land on the Kelani River, near Colombo, still bears the name of "Orta Seda," the silk garden. The Dutch attempted to introduce the true silkworm (*Bombyx mori*) during the governorship of Ryklof Van Goens, who, on handing over the administration to his successor in the year 1663, informed him that a trial had been made at Jaffna Palace to rear silkworms and produce silk; he stated that he had planted a number of mulberry trees, which were growing well, and recommended that their cultivation should be extended to other places. In the British period, Bennett introduced the white and digitated mulberry, and, in 1829 a Government regulation was passed to encourage the cultivation of silk as well as of other agricultural products. Subsequently, attempts were made by a coffee planter in

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Haputale, whose silk met with a favourable report, but the difficulty of securing careful skilled labour and the injurious effect of thunderstorms on the silkworms prevented the continuation of his experiments. A great interest was taken in sericiculture by Sir William Gregory, who introduced and distributed Japanese silkworm eggs in Ceylon. He reported in the year 1872 that the mulberry tree grew quickly and vigorously in Ceylon, that the silkworms throve well, but that there was considerable difficulty in finding patient and skilled hands to wind the silk.

In the "Ceylon Administration Reports" for 1902, Mr. Green gives an account of some interesting experiments which he has carried out at Peradeniya. Some eggs of the Chinese silkworm (*Bombyx mori*) were procured from the Instituto Bacologico Susani, Milan. The silkworms which hatched out were chiefly of the "Indigenous Yellow" variety. They fed freely on the local mulberry leaves (*Morus alba* var. *indica*), grew rapidly, remained perfectly healthy, and spun their cocoons. The moths from these cocoons yielded a supply of eggs.

It has been found by experience in India that to ensure a healthy brood of silkworms it is advisable to send the eggs to the hills or a cold climate for some months before allowing them to hatch. In order to imitate these conditions, one-half of the locally produced eggs were kept for six months at a temperature of 45° F. in a cold storage establishment, whilst the remainder were left at the ordinary temperature. The unexpected result occurred that the eggs which had been submitted to a low temperature for six months hatched within a fortnight of their return to ordinary conditions, whereas the remainder had not yet hatched when the report was written.

A large brood of healthy silkworms was thus obtained, but during the last stage of their growth, great difficulty was experienced in obtaining sufficient food, all the mulberry trees in the locality having been already stripped. The consequence was that the worms developed very unevenly, and began to spin prematurely, a crop of under-sized cocoons being produced. Other foods were tried, but without success. The "Paper Mulberry" (*Broussonetia papyrifera*) was wholly refused; lettuce leaves were only nibbled at, and the young leaves of *Ficus religiosa* were eaten very sparingly and unwillingly. It is possible, however, that if the silkworms were accustomed to the young *Ficus* leaves from their infancy, they might be raised on this food, and experiments in this direction are being made. The crop of cocoons finally obtained, although somewhat undersized, were examined by an expert and reported to be of distinctly good quality.

erici- ulture in eylon.

These experiments have demonstrated the practicability of producing healthy silkworms and good cocoons in Ceylon, but the difficulty met with in providing food shows the futility of attempting to introduce the industry of sericiculture amongst the natives until mulberry trees have been widely cultivated throughout the island. With this object, large nurseries of mulberry trees are being planted, and it is proposed to ask the aid of the Government agents of the several provinces to assist in the distribution of the plants.

A sample of the pierced cocoons of the large Indian silkworm (*Attacus ricini*), which had been produced in Ceylon, was sent to the Government entomologist by Mr. P. N. Braine. This silkworm feeds on the castor oil plant and could, therefore, be cultivated in Ceylon without difficulty. The sample was submitted to an expert who reported that it was of good quality, and that five or six years ago such cocoons were worth 3*s.* 6*d.* per lb. for the manufacture of silk plush, but that the demand for that material having since declined, their value at the present time was only 8*d.* per lb. Since there are more than 1,600 of these cocoons in one pound, it is evident that at the existing prices their cultivation would scarcely prove remunerative.

In conclusion, Mr. Green states that it is doubtful if the rearing of silkworms in Ceylon would ever repay European attention, but that if the natives could be induced to take an interest in it, it might be established as an additional source of profit to them. To this end he recommends the Government to encourage the establishment of the industry by supervising it in its early stages and by offering prizes for the best crops of cocoons.

THE VEGETABLE FATS AND WAXES OF INDO-CHINA.

The seeds of many plants contain solid, fatty or wax-like substances which are often of considerable economic value. These vegetable fats are solid at the ordinary temperature and present a variety of gradations from the soft, butter-like masses of cotton-seed stearin to the hard and brittle Japan wax. They are composed of glycerides of fatty acids or, in other words, are compounds of glycerol with certain fatty acids of which the most commonly occurring are stearic, palmitic, and oleic acids. The glycerides of stearic and palmitic acids are solid substances at the ordinary temperature, whilst that of oleic acid is a liquid. The consistence and degree of hardness of

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a vegetable fat are thus largely dependent on the relative proportions of the glycerides of which it is composed. These fats or glycerides may be decomposed into glycerol and their constituent fatty acids by heating them with alkalis or acids, or by means of superheated steam. These processes of saponification are practised on an enormous scale in the manufacture of soap and candles, glycerine being obtained as a bye-product. Some of the fats of this class, especially cotton-seed stearin and cocoanut oil, are also employed in the manufacture of artificial butter.

The plants from which these tallows and waxes are derived are very widely distributed, but occur most abundantly in tropical and semi-tropical countries. Many of these products are already recognised as important articles of commerce, whilst many others promise to be so in the near future when their values for particular purposes have been better ascertained and the best means adopted of extracting and refining them.

A brief account of the most important vegetable tallows and waxes of Indo-China has been compiled recently by M. Lemarié, Director of Agriculture, Annam.

DIKA BUTTER.

This product, which is also known as "oba," or wild mango oil, is obtained from the seed-kernels of *Irvingia Barteri*, a tree indigenous to the West Coast of Africa.

The kernels contain from 60 to 65 per cent. of fat, which is extracted by the natives by boiling the seeds with water and afterwards subjecting them to pressure. The Dika butter thus obtained is white and has a sweet odour and an agreeable taste, but, on keeping, becomes yellow and rancid. This fat contains the glycerides of lauric, myristic, and palmitic acids, together with from 1 to 10 per cent. of free acids. It is readily saponified, and is used for the manufacture of candles, and also as a substitute for cocoa-nut oil in the manufacture of marine soap.

Percentage of Fat in Seed-kernels.	Specific gravity at 15° C.	Melting Point.	Saponification Value.	Iodine Absorption Value.
60—65	0·820 (?)	30–32° C.	173	30·9—31·3

Specimens of the Dika fruit have been received at the Imperial Institute from Gambia and from Northern Nigeria. The tree is known by the natives of West Africa as the "udika," "dika," "dita," "oba," and "iba" tree, the second and third of these native names being also applied to the fruit. The pulp of the latter is eaten by the natives of Gambia, who also pound the small, white seeds embedded in the pulp of the fruit into a mass which, after the removal of the solid tallow thereby caused to exude, constitutes "dika or Gabon chocolate."

Irvingia Butter.

The kernels of the seeds of *Irvingia malayana*, the candle-tree of Indo-China, contain about 50 to 60 per cent. of fat, which is extracted by the natives by primitive methods, and is known by them as "cây-cây." This fat is completely saponified by alkalis, yielding a white, nacreous soap which dissolves readily in alcohol.

Since the husk constitutes more than 80 per cent. by weight of the seed, it is found necessary to decorticate the seeds before sending them to the factories in order to reduce the cost of carriage.

Percentage of Fat in Seeds	Percentage of Fat in Kernels.	Melting Point.	Solidifying Point.
10·5	52·0 – 56·7	37·5 – 38° C.	35·5 - 36° C.

Chinese Vegetable Tallow.

This vegetable tallow, known to the natives as "pi-yu," is obtained from the seeds of *Sapium sebiferum*. The following method of extraction is one often employed by the Chinese. The kernels are carefully removed from the hard, outer shells, and the latter are placed in a large, wooden drum provided with numerous holes. They are then heated by means of a current of steam when the melted tallow runs out of the drum into the receiving vessel placed beneath it. After the tallow has solidified, it is re-melted, filtered, and cast into cakes each weighing about 1 cwt., which are exported to Europe. The tallow is thus obtained as a pure white or slightly grey mass. It is completely solid at ordinary temperatures, and leaves no grease spot when placed on paper. It is free from odour, and consists principally of palmitin, together with a very small proportion of stearin.

The kernels of the seed yield, on expression, an oil termed "tsé-iéou," or "ting-yu." This oil is a liquid, possesses drying properties, and is used both as an illuminant and also in the manufacture of varnish.

"Mou-iéou" is the mixture of "pi-yu" and "ting-yu" obtained from the whole seeds by a combination of the processes described above. Both "mou-iéou" and "pi-yu" are sold under the name of Chinese vegetable tallow, but the former is not so hard or white as the latter; it also has a slight odour, and gradually becomes yellow, or even brown, on exposure to the air. It gives a slightly acid reaction, due to the presence

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of propionic acid. Large quantities of Chinese vegetable tallow are now employed in England for the manufacture of candles, and its use on the Continent is gradually extending.

The seeds of *Sapium sebiferum*, known locally as "cây-sói," yield 60 per cent. of shell and 31 per cent. of kernels. The shell contains 29·5 per cent. of a white, solid fat, whilst the kernels contain 59·5 per cent. of oil.

"Pi-yu" has a specific gravity 0·918 at 15° C., and melts at 44·5°, whilst "mou-iéou" has a specific gravity 0·915 at 15° C., and melts at 35° C.

CHAULMOOGRA OR GYNOCARDIA OIL.

The "krebao" seed of Cambodia is the product of one or more species of *Hydnocarpus* of the natural order, *Bixineæ*. It is known by the Chinese as "ta-fung-tze," and is used for medicinal purposes in Hanoi under the name of "dai-phong-tu."

This seed yields rather more than 30 per cent. of oil on expression, whilst by extraction with ether 50-52 per cent. is obtained. When freshly prepared, chaulmoogra oil is white, odourless, and tasteless; if, however, the oil is not fresh, or if it has been extracted from old seeds, it has a light brown colour, and an odour resembling that of bird-lime. The fat obtained by expression remains solid up to 17° C., whilst that obtained by extraction is only solid below 14° C.

In Indo-China and Siam this oil is employed for many purposes, but chiefly as a remedy for rheumatism, gout, and skin diseases.

JAPAN WAX.

The most important sources of this vegetable wax are *Rhus succedanea* and *R. vernicifera*; it is also said to be obtained from *R. sylvestris*. The first two species are found both in China and Japan, but the third occurs in Japan only.

Various methods are adopted for extracting the wax. According to one method, the fruit, either with or without its external envelope, is ground between millstones, the resulting mass is then submitted to the action of steam and pressed from time to time, and in this way the different qualities of wax are obtained which are supplied to the refiner.

In another method the meal is boiled with water in large cauldrons, and the wax which rises to the surface is removed by decantation.

In a third method, the fruit is broken with flails, and, after being left for a fortnight to dry, is gently roasted and afterwards ground. The paste thus obtained is placed in small bags and exposed to a current of steam in order to melt the wax, which is then obtained by expression.

Occasionally the wax is extracted by means of solvents, such

The Vegetable Fats and Waxes of Indo-China.

as ether or carbon disulphide, and the product thus obtained is of a paler green colour than that obtained by expression.

The wax is next submitted to a washing process which renders it granular; it is afterwards bleached. The distinction between the various commercial qualities is based on the degree of whiteness of the wax after the refining operations.

The last traces of wax left in the residue from the presses are extracted by adding about 10 per cent. of oil of perilla (*Perilla ocymoides*), or "ye goma," and again submitting the mass to pressure. This addition of a small percentage of oil naturally causes the product to be of a softer consistence, and it is for this reason that the Japan wax of commerce varies so greatly in hardness.

Japan wax is sent into the market in chests each containing about a picul (62½ kilogs.), and is the most important vegetable wax of commerce. It somewhat resembles bees'-wax, but is paler in colour. It is hard and brittle, and possesses a crystalline structure. If the wax contains much moisture it gradually becomes coated with a fine white dust which consists of minute prismatic crystals. It melts at 53-54° C., and solidifies at 40·5-41° C., but, if again heated, it melts at 42° C., and only regains its original melting point after standing for a considerable time. The specific gravity of the crude wax is 1·006, whilst that of the bleached wax is between 0·970 and 0·980. It consists chiefly of palmitin, together with small quantities of the glycerides of volatile fatty acids.

This wax is largely used in Japan for the manufacture of candles and for polishing turned wooden goods. In Europe, it is utilised in the composition used for the manufacture of wax matches and also for polishing purposes by cabinet-makers and bootmakers. It is also employed for mixing with bees'-wax for certain varieties of candles, since it increases the facility with which they can be moulded.

A sample of the seeds of *Rhus succedanea* ("cây són") examined in Tonkin yielded 6·5 per cent. of solid wax. The amount usually found in these seeds, however, varies from 22 to 26 per cent.

Fats derived from the Dipterocarpeae.

A large number of trees of the natural order of *Dipterocarpeae* produce seeds which contain a large proportion of fat. Many of these fats are well known in the markets of Europe. The most important of such trees occurring in Indo-China are *Shorea aptera, Isoptera borneensis*, and *Vateria indica*. The fats obtained from the two first of these are almost indistinguishable from one another.

Borneo tallow is a product of several forest trees, but notably of *Shorea aptera* (Burk.) and *Isoptera borneensis* (Scheff.).

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When the hard fruits fall from the tree, they are left for some time in a damp place until the shell breaks and the seed begins to germinate. They are then dried in the sun, and the kernels are separated from the pericarp and placed in baskets made of rattan or bamboo canes, which are suspended over pots of boiling water. When the kernels have become soft and pasty they are placed in bags and pressed. The fat thus obtained is moulded in the internodes of bamboo stems and so acquires the cylindrical form in which it is found in commerce. Borneo tallow is employed by the natives for culinary purposes, is exported to England for use as a lubricant, and is also used in Manila for the manufacture of candles. It contains about 95 per cent. of saponifiable fats, which consist of stearin and olein, the latter being present in rather smaller proportion than in animal tallow.

Piney or Malabar tallow is obtained from the seeds of *Vateria indica*, a tree indigenous to the East Indies and Malabar. The fat is extracted by grinding the previously roasted seed and boiling the meal with water; it then rises to the surface and is skimmed off.

Piney tallow is tasteless and inodorous; it has at first a pale yellow colour but gradually becomes quite white. It has a consistence between that of stearin and wax, and a granular, crystalline structure. It contains about 2 per cent. of a volatile oil which possesses a pleasant odour; this oil can be extracted by alcohol, leaving the pure fat, which consists of palmitin (75 per cent.) and olein (25 per cent.).

Piney tallow is readily saponified by alkalis. It is highly esteemed for the manufacture of candles, since it burns steadily and emits an agreeable, aromatic odour.

	Specific Gravity at 15° C.	Melting Point.	Solidifying Point.	Saponification Value.	Fatty Acids.	
					Melting Point.	Solidifying Point.
PINEY or MALABAR TALLOW.	0·915	40° C.	30·5° C.	191·9	57° C.	55° C.

FATS DERIVED FROM THE LAURACEAE.

The natural order *Lauraceae* is represented in Indo-China by a large number of genera and is almost as important as the *Dipterocarpeae*. It is better known, however, for the volatile oils which many of its members yield than for the fats contained in the seeds of certain genera.

Tetranthera laurifolia, Jacq. ("bói-lói") is a tree of Asiatic origin, but has been introduced into America. The seeds, when boiled with water, yield "lalreu" tallow, or "undung," which is employed in the manufacture of candles.

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Tetranthera citrata, Nees., *T. glabraria*, Nees., and *T. Roxburghii*, Bl. also yield similar products.

Persea gratissima produces a large fruit known as the "advocate pear," this name being a corruption of the Brazilian word "aguacate," by which the tree is known in the country of its origin. Its cultivation has extended to most tropical countries, and it has already become a common tree in Indo-China, although only recently introduced. The pulp of the fruit is edible, is known as "vegetable butter," and on expression yields a large percentage of oil, which is used as an illuminant and also for the manufacture of soap.

Cylicodaphne sebifera, Bl., is a tree which is indigenous to the western districts of the island of Java, but has spread to the continent of Asia. Its seeds contain from 40 to 15 per cent. of a fat known as "tangkallah" fat, which melts at 45° C., and is composed of olein (11 per cent.) and laurostearin (85 per cent.). It is utilised in the manufacture of candles and soap. It is said that the seeds produced annually by one tree provide sufficient material for the manufacture of 500 candles.

THE DETERIORATION OF CUT SUGAR-CANE.

It is well known that when the outer wall of the sugar-cane is broken and air thereby admitted to the cell contents the sucrose or crystalline sugar contained in the latter gradually changes into non-crystalline invert sugar; this action seriously affects the value of the cane to the sugar manufacturer, and it is therefore desirable that canes should be treated at the factory as soon as possible after cutting. Experiments have from time to time been undertaken to determine the rapidity with which this deterioration proceeds, but the results have as a rule been untrustworthy, owing to lack of uniformity in the material used.

In a recent number of the Agricultural Ledger (1903, No. 6) the results of some experiments are given in which this difficulty was avoided; these show in a striking manner the amount of deterioration (that is, the decrease of the available sucrose) which occurred in the course of periods varying from one to five days.

The author determined the deterioration of the sucrose content of five varieties of sugar cane, viz., "White Manilla," "Purple Cheribon," "Manilla," "Dikchan," and "Rukhra." Each cane was divided into four or five uniform samples, preliminary experiments having shown that no change was produced by cutting the canes in this manner, and the percentage of available sugar was determined in each at intervals of one day. In the case of the three first-named varieties these tests were continued for five days, and in the case of the last two varieties, for four days.

The Deterioration of Cut Sugar-cane.

The results so obtained are given in the following table :—

Days Cut	0.	I.	II.	III.	IV.
Total loss of available Sugar, per cent....	0·0	2·7	8·0	21·4	32·1
Daily loss of available Sugar, per cent....	0·0	2·7	5·3	13·1	10·7

These figures show that in the first two days the loss is relatively small, but after three days, more than one-fifth of the available sugar has disappeared. In practice, therefore, the canes should be received at the factory not later than 24 to 36 hours after cutting.

THE UTILISATION OF MOLYBDENUM ORES.

The rapidly increasing use of the metal molybdenum in the manufacture of tool steels, armour plate, &c., has necessitated the discovery of some method by which poor molybdenum ores may be concentrated to contain at least 50 per cent. of the metal, since ores less rich than this cannot be profitably smelted. Molybdenite, the principal source of molybdenum, is found widely distributed in various localities in New Brunswick, Ontario, Quebec and British Columbia. It occurs in association with quartz and also in granites, gneiss and pegmatites, associated with pyrites, mica and other minerals,

So far the mineral has generally been concentrated by hand-picking. Several methods have been devised for the mechanical concentration of the ore and some recent experiments in this direction made by Mr. J. W. Wells of the Kingston School of Mines appear to have met with success. The method is simple and depends upon the fact that molybdenite when passed through rolls does not become pulverised but separates into flakes whilst the accompanying minerals are crushed to powder. As an illustration of the application of the process it may be stated that a sample of ore containing 50 per cent. of pyrrhotite, 10 per cent. of pyrites and 6·5 per cent. of molybdenite in addition to calcite, mica, quartz, pyroxene, &c., after passing through rolls and being screened through a 0·2 inch sieve, furnished 1·4 per cent. of flakes consisting principally of mica and molybdenite. After a second screening through a 0·10 inch mesh a further 1·54 per cent. of material of similar composition was obtained. The two concentrates in each case contained about 55 per cent. of molybdenite and 45 per cent. of mica.

To separate these minerals several methods were tried such as "jigging" and the Elsmore oil process but the best results were obtained with the Wetherill magnetic separator which removed practically all the mica and gave an ore containing 90 to 91 per cent. of molybdenite.

Bulletin of the Imperial Institute.

NOTICES OF SOME RECENT UNOFFICIAL PUBLICATIONS.

(All these books have been added to the Imperial Institute Library.)

PROSPECTING FOR MINERALS. A practical handbook for prospectors, by S. Herbert Cox, A.R.S.M. Pp. xi. + 213. (London: Charles Griffin & Co., Ltd., 1903.)

This volume is one of the "New Land" series edited by Professor Grenville Cole, and is intended as a guide to those interested in the utilisation of the mineral resources of new countries.

After an introduction on the petrological nature of the earth's crust, the author gives a brief account of the methods employed in the identification of minerals, followed by a description of the principal rock-forming minerals and gemstones. The next five chapters are devoted to descriptions of the occurrence and origin of useful minerals, illustrated by examples selected from typical deposits in various parts of the world. The remainder of the book contains descriptions of the principal metalliferous ores, their composition, physical constants and blow-pipe tests being given in tabular form, and also a short chapter on the geology of coal and petroleum deposits. The book contains a number of diagrammatic illustrations of mineral deposits, and a glossary of mineralogical and mining terms.

WATER SUPPLY: A STUDENT'S HANDBOOK ON THE CONDITIONS GOVERNING THE SELECTIONS OF SOURCES AND THE DISTRIBUTION OF WATER. By Reginald E. Middleton, M.Inst.C.E. Pp. vi + 168. (London: Charles Griffin & Co., Ltd., 1903.)

This work deals with the problems confronting both the civil engineer and the analyst in the selection, purification and distribution of water to communities. The first two chapters are devoted to the consideration of the "source" of water and to the deductions to be drawn from analytical data as to its purity. In the course of these chapters a summary of the principal characteristics of spring, well and upland surface waters is given. The succeeding portions of the book deal with such engineering problems as the mechanical purification of water, the construction of reservoirs and masonry dams, the flow of water through pipes, the selection of distributing systems, and the choice of pumping machinery.

AGRICULTURAL GEOLOGY. By J. E. Marr, M.A., F.R.S. Pp. xi. + 318. (London: Methuen & Co., 1903.)

This book has been written for the use of students intending to compete in examinations in agriculture. It is based on the

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requirements set forth in the schedule framed for the guidance of candidates for the International Diploma of Agriculture. It gives in a condensed form an account of the composition and structure of rocks; the operations of geological agents and the formation of soil; geological surveying, including an explanation of geological maps and sections; the strata of the British Isles; water supply and the materials of rock origin used for improving soils. The various geological terms and actions are illustrated by 104 figures and a geological map of the British Isles.

THE SOIL: AN INTRODUCTION TO THE SCIENTIFIC STUDY OF THE GROWTH OF CROPS. By A. D. Hall, M.A. (Oxon.), Director of the Rothamsted Station. Pp. xiii. + 286. (London: John Murray, 1903.)

In the domain of science applied to agriculture the problems relating to the soil seem at first sight to be some of the simplest to attack and solve. It would be expected that a plain chemical analysis showing the relative proportions of the soil constituents would throw a clear light on the differences in fertility and on the manurial needs of the soil; but the experience of the last 60 years since Liebig wrote his works on agricultural chemistry, bringing the knowledge of that time to bear on agriculture, has shown that the relation of the soil to the growth of the plant is one of the most complex of farm phenomena, and the one in which forecasts are hardest to make. The researches of the last two decades have done much to elucidate the work that goes on in the soil, especially that done by micro-organisms. This book summarises our present knowledge on this subject. It gives an account of the chemical, physical and biological processes by which the plant is supplied with its food. Whilst a certain knowledge of chemistry is assumed, the treatment of the subject is intended to be intelligible to the non-technical reader, the principal object being to explain the reasons underlying the best farming practice. The book contains photographs and diagrams illustrating the subject matter and a bibliography of the various subjects dealt with, so that the reader can refer to the original papers.

AGRICULTURE FOR BEGINNERS. By C. W. Burkett, F. L. Stevens, and D. H. Hill, Professors in the North Carolina College of Agriculture and Mechanic Arts. Pp. xii + 267. (Boston, U.S.A., and London: Ginn & Co., 1903.)

This book is intended for the use of schools; in it the attention of the pupil is directed to the everyday occurrences of the farm—its soil, crops, orchard, live stock, and dairy, and also

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to the vegetable and insect pests that attack its plant life, and various simple experiments are suggested which pupils may carry out for themselves. The book contains numerous illustrations.

ANIMAL AND VEGETABLE FIXED OILS, FATS, BUTTERS, AND WAXES: THEIR PREPARATION AND PROPERTIES, AND THE MANUFACTURE THEREFROM OF CANDLES, SOAPS, AND OTHER PRODUCTS. By C. Alder Wright, D.Sc. (Lond.), B.Sc. (Vict.), F.R.S. 2nd Ed., edited and partly rewritten by C. Ainsworth Mitchell, B.A. (Oxon), F.I.C. Large 8vo., pp. xvi. + 804, with 2 plates and 154 illustrations. (London: Charles Griffin & Co., Ltd., 1903.)

This work deals with the sources, production and general technology of the numerous fixed oils and allied substances of animal and vegetable origin. A description of the machinery employed in the extracting, bleaching, and refining processes is given. Another section deals with the methods and apparatus employed in the manufacture of soap, candles, tapers, night lights, and glycerine. The source, composition, and properties of each of the various oils and fats are considered in detail, and the values of the physical and chemical constants recorded by different observers are given in tabular form. In this edition, the late Dr. Alder Wright's work has been considerably enlarged, and its scope extended in various directions. For example, a new chapter of 200 pages has been added, dealing with the adulterations of oils and fats and their detection. The volume has also been brought up-to-date, and is illustrated.

FOODS: THEIR COMPOSITION AND ANALYSIS. A Manual for the use of Analytical Chemists and others. By A. Wynter Blyth and M. Wynter Blyth. 5th Ed. Pp. xxv. + 616. (London: Charles Griffin & Co., Ltd., 1903.)

This book is intended for the use of those engaged in the examination of foods and drugs. The new edition contains descriptive accounts of a large number of new analytical processes with a view to meeting the requirements of modern legislation on the subject of impurities and adulterants in foods. In this connection mention may be made of the summary of methods recommended by various authorities for the detection of minute quantities of arsenic, the chapter on the sophistication of spices, in the course of which a tabular statement of the analytical constants of the more common spices is given, and the short account of bacteriological methods of examining water.

THE MICROSCOPICAL EXAMINATION OF FOODS AND DRUGS. By Henry George Greenish, F.I.C., F.L.S., Professor of Pharmaceutics

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to the Pharmaceutical Society of Great Britain. Pp. xxiv. + 321, with 168 figures in the text. (London: J. & A. Churchill, 1903.)

The importance of the microscopical examination of foods and drugs for the purpose of ascertaining their purity was recognised in 1900 by the stipulation of the Local Government Board that persons appointed as public analysts must produce evidence of proficiency in this subject, and the Institute of Chemistry has now established a special examination to meet the requirements of the Board in this respect.

The book under notice is said to be the first English text-book specially devoted to practical instruction in the methods employed in the microscopical examination of vegetable foods and drugs. It is divided into twelve sections, representing different classes of vegetable products, viz., starches, hairs and textile fibres, spores and glands, ergot, woods, stems, leaves, barks, seeds, fruits, rhizomes and roots. Representative specimens of each of these classes are described. Instructions are given for the preparation of specimens for microscopical examination, and the diagnostic characters of the different foods and drugs are indicated, the descriptions being supplemented by numerous illustrations.

The book includes descriptions of the more important drugs and of a number of food materials such as tea, cocoa, coffee, chicory, peas, pepper and mustard. In addition, it gives the microscopical characters of a number of commercial fibres, including cotton, flax, hemp, Manila hemp, jute and wool.

IN THE ANDAMANS AND THE NICOBARS. By G. Boden Kloss (London: John Murray, 1903.)

The first part of the volume is devoted to the narrative of a cruise made by the author, in company with W. L. Abbott, amongst the Andamans and Nicobars from October, 1900, to April, 1901. The primary object of the expedition was to collect natural history and ethnological specimens, special attention being given to the mammalia. In the second or general part of the book, the author brings together the information known hitherto concerning the Archipelago. He points out that at first sight the chain of islands seem to indicate a past connection between Burma and Sumatra. Soundings support the probability of the Andamans being a seaward extension of the Arakan Yana peninsula of Burma, but between the most southern of the Nicobars there is a deep channel of over 1,000 fathoms. The probability of a connection with Burma is also supported by the affinities of the flora, the absence of Malayan mammals, and the similarity in geological structure of the Arakan range and the Andamans. Timber is the most

Notices of some recent Unofficial Publications.

important product of the Andamans, and many of the woods are well adapted for commercial purposes, and under the superintendence of the Forest Department are utilised for local requirements and also exported to India and Europe.

The Nicobars contain few important trees, but do a considerable export trade in rattans. They are also rich in building stones. In the appendices lists are given of the forest trees, with their vernacular and scientific names and notes on their uses.

The book is illustrated by reproductions of photographs.

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